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LIGHT LAMPS FITTINGS AND ILLUMINATION

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Natural and Artificial Light

THE discussion opened by Mr. J. S. Dow at the last meeting of the Illuminating Engineering Society, on April 24th (see pp. 167-174), dealt with a number of interesting problems and covered somewhat novel ground. Natural light forms the basis of the original method of illumination. It is frequently affirmed that the human eye has been so developed as to make the best use of daylight, and that therefore we should take natural lighting as our guide in designing artificial lighting installations. Much may be learned from the study of daylight. It has good qualities which are not always present in artificial lighting, but we need not imitate the imperfections of natural lighting arising from the manner in which it is admitted through windows. Also there is much to be said for the view that artificial lighting, being more completely under control, has possibilities that do not exist when daylight is used. In certain interiors (theatres, picture palaces, etc.) the senses are gratified by a departure from ordinary natural lighting conditions; much of the charm consists in the skilful production of novel effects. Moreover, as Mr. C. C. Paterson remarked in the discussion, conditions at night may well have played quite as important a part as conditions by day in determining the evolution of the eye. Daylight itself undergoes great variations in colour during different periods of the day, and according to changes in climatic conditions. Probably the most significant factor of all is the enormous range of adaptation acquired by the eye in response to fluctuations in the brightness of daylight.

Imitation of daylight seems to be chiefly worth considering either in cases where the best available illumination for carrying on work is needed, or in those numerous cases where artificial light has to be frequently used as a supplement to natural lighting. The discussion revealed general agreement that the use of fully corrected artificial daylight for general lighting is not desirable. There are certain processes, involving accurate colour-matching, where the qualities of such artificial daylight are very valuable. But otherwise the loss, through absorption, of a considerable proportion of light (estimated by some speakers to be as much as 80 per cent.) is not justified, and the "cold" nature of the light is also a drawback.

A better case can be made out for the use of partially corrected or "modified artificial daylight," where the loss of light need not exceed more than about 25 per cent., and where the light is of a warmer tint. Light of this character may be visually indistinguishable from daylight, with which it "mixes" well. Also, whilst it is inferior to fully corrected artificial daylight in revealing colour values, it is at least very much better than uncorrected artficial light in this respect. There are many installations, art galleries, shops, devoted to coloured goods, etc., where this quality would be welcome. Even in the case of this modified artificial daylight there is some danger that the effect may be "cold," but it was suggested by the author that much may be done by the skilful use of warmer colours for the decorative scheme to remove this impression.

One of the most interesting problems raised in the paper was the alleged superiority of daylight and forms of artificial daylight in relation to acuteness of vision. Many conflicting statements on this subject have been made. The lecturer was able to throw some light on this question by a series of demonstrations illustrating the appearance of detail when seen respectively by red and blue light. Apparently the chromatic aberration of the human eye is a factor of some consequence, but the impression received may vary according to personal peculiarities—for instance, it seems to depend on whether the observer is "short-sighted" or "long-sighted."

The author also sought for an explanation of the familiar difficulty in working in a "mixed light." The difficulty is doubtless accentuated by the difference in colour of natural and artificial light. But there is good reason for supposing that it is also due in a measure to the contrast-effect of the overhead sky—of which Mr. Cunnington mentioned several instructive examples.

In the final portion of the paper the author touched upon one other question of which little is definitely known—the psychological effects of light of different colours. The "cold" nature of installations in which some form of artificial daylight is used has frequently been the subject of comment. It may be, as Mr. Buckell suggested, that the impression becomes less evident when the blue glass surrounding the lamp is hidden. But there seems some ground for the general belief that on the whole red and orange light tend to be stimulating whereas green and blue have a sedative effect; this may be worth bearing in mind when arranging the light of a shop, a restaurant or a factory.

All these matters deserve further investigation. Meantime it should be regarded as an indication of progress that illuminating engineers are beginning to devote attention to the importance of variation in *quality*, as distinct from *intensity*, of light.

The Lighting of the Parks

THE recent experience of Sir Leo Money and his companion has brought into prominence the question of the lighting of the parks of London, which was the subject of a series of questions addressed to Sir W. Joynson-Hicks in the House of Commons on May 10th. Mr. Hannon enquired whether Hyde Park is not "the worst lighted park in Europe, having regard to its importance." Sir William in reply mentioned that he had received information that it was not well lighted. He was asking the First Commissioner of Works to enquire into the matter. It was suggested that the lighting of other parks should also be investigated.

Whilst, as Sir William pointed out, the whole question of the lighting of Hyde Park cannot be dealt with in a couple of days, we hope that the enquiry will ultimately lead to a substantial improvement. The lighting of our parks has for long been obsolete, judged by modern conditions. They are no longer to be regarded as "wild areas." The volume of traffic through them is continually increasing, and they are much used by people during the evenings—though still to a less extent than some of the Continental parks.

In places of entertainment good lighting has proved to be a valuable safeguard, not only preventing offences but also protecting innocent members of the public against possible misunderstanding and unjustified suspicion. The effect of the wide publicity given to incidents of this nature is to deter respectable people from using the parks at night—the only time when many people are free to enjoy them.

Inevitably the cost of better lighting has been mentioned as a difficulty. Yet we observe that the annual cost of the police regularly employed in Hyde Park is as much £25,000 per annum, whereas we should probably be correct in saying that the annual cost of the lighting is less than a tenth this sum. Reasonable expenditure on better lighting would therefore surely be justified. It is not suggested that the entire area of Hyde Park must be flooded with strong light. But it should be possible to illuminate the main paths and roadways, and the areas normally frequented by the public, sufficiently brightly to protect innocent members of the public from suspicion. In the dark all persons are suspect. During the war the floodlighting of areas adjacent to arsenals, etc., proved useful, not only in rendering the approach of badly disposed persons more difficult, but also in relieving others of the fear that they might be seen indistinctly and shot before explanations could be offered! There is a familiar saying that "one lamp is as good as two (or is it three?) policemen." Whilst the relative efficiencies of police officers and public lamps can hardly be expressed in terms of such a simple relation, we think that most people would agree that it is pleasanter to be kept in order by the latter agency!

Much might be done by better lighting to render our parks more attractive as well as safer places by night and to make them centres of social pleasures on fine summer evenings. There is really no reason why London should not enjoy a larger measure of the outdoor life characteristic of some Continental cities. Apart from the utilitarian aspects of lighting referred to above, there are opportunities for the production of pleasing effects in the form of floodlighted foliage and flowers, which would help to render our parks agreeable places by night and dispel the air of gloom in which they are apt to be shrouded. The decorative aspects of public lighting are judged worthy of consideration in our main thoroughfares. Why should they not be exploited also in our parks and open spaces?

A City of Light

PRIVATE ENTERPRISE SUPPLEMENTS PUBLIC EFFORT.

THE remarks made in the preceding note on the lighting of parks lead us to refer next to a notable tendency in exterior lighting—the supplementing of public effort by private enterprise.

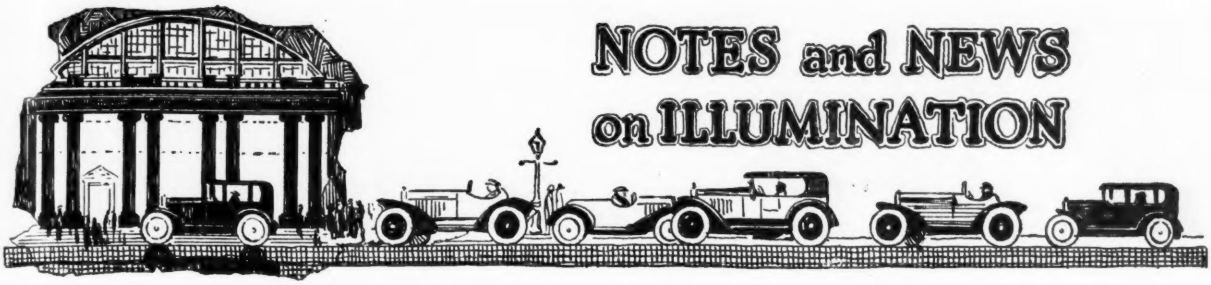
There seems an opening for more constructive private enterprise in connection with public lighting. Isolated instances might already be mentioned in which private lighting has helped public lighting considerably. We need only mention the "parade lighting" initiated in some commercial areas with the co-operation of local merchants, and the growing practice of leaving show windows illuminated by night. The floodlighting of buildings, and even, in some degree, the use of illuminated signs (provided they are not too dazzling nor too intermittent) likewise aid public lighting by brightening the streets, at the same time affording an appreciable contribution to the illumination on the roadway.

In some American cities the plan of appealing to private interests to supplement public lighting has been carried to greater lengths. One method is to induce owners of premises in exceptionally well-lighted areas to contribute to the first cost of the installations from which they benefit. There is also a tendency to aim at creating a civic pride in the lighting of a city—to educate public opinion instead of appealing direct to local authorities, who are apt to be dominated by the fear of adding burdens to the rates.

An interesting experiment is to be tried this autumn in Berlin, in connection with the "Lichtfest" during October 13th-16th. This is a sequel to several other similar enterprises on a smaller scale. Shop-lighting campaigns recently have been initiated in several cities throughout Germany with good results. In Frankfort the "Lichtfest" last December, when many important public buildings were floodlighted, is said to have produced an excellent effect. The plan of lighting up Berlin ("Berlin im Licht") is now being taken up with enthusiasm. At a gathering on April 18th representatives of forty Berlin business organizations were present; likewise the Oberburgmeister and others associated with its municipal affairs.

The promoters emphasize the fact that the display is not organized solely in the interests of the lighting industry, though naturally they will benefit. It is rather an attempt to apply light on a large scale to draw attention to Berlin as the "heart of Europe," and to bring home to its population the benefits of artificial lighting. The illumination of the city will be conducted on a uniform plan. Floodlighting of important public buildings will play a prominent part. There is to be no dazzling of observers by glaring show windows or unsightly illuminated signs. The aid of leading architects has been enlisted to secure pleasing and artistic effects.

Experience in connection with the "Lichtfest," in Frankfort, showed that many different sections of the community derived direct benefit from the display. To the public, especially in commercial circles, it was instructive. It was of distinct advertising value to the city, and the influx of visitors must have been good for business generally. To all concerned in the lighting industry it was of manifest value in drawing attention to the possibilities of artificial lighting, and thus paving the way for more business in the future. No doubt the display at the British Empire Exhibition at Wembley had a similar effect. We are probably only at the beginning of the use of light on a large scale as a basis of co-operative publicity and we shall watch this experiment in Berlin with interest.



The Association of Public Lighting Engineers

FIFTH ANNUAL CONFERENCE IN SHEFFIELD.

Full particulars of the above conference, which will take place in Sheffield during July 9th–12th, are now available. Several interesting papers are to be read, including one by Mr. J. M. Waldram on "Visibility," but the item that will no doubt attract most attention is the inspection of the street-lighting installations which are being arranged with a view to showing how the Standard Specification may be complied with in practice. The Association dinner will be held at the Grand Hotel on July 11th, and excursions and visits to local factories of interest have been arranged. Fuller particulars may be obtained from the Secretary, Capt. W. J. Liberty, 68, Victoria Street, London S.W. 1.

Street Lighting in Leicester

The annual report of the Superintendent of Public Lighting in the City of Leicester (Mr. Thomas Wilkie) as usual makes interesting reading. The cost of public lighting was represented by a rate of 4.29d. per £ during 1927, which is considerably lower than the figure recorded for the previous three years. Nevertheless the total candle-power provided (approximately 700,000 by gas lamps and 100,000 by electricity) is higher than ever before. The cost of the lighting per head of population amounted to 2s.—surely a very reasonable item! Steady progress towards the "levelling up" of gas consumption has been made, burners consuming $3\frac{1}{2}$ cubic feet per hour being widely used. A noteworthy point is the steady improvement in the efficiency derived from gas lamps, which was 27.67 candles per hour per cubic foot in 1927 as compared with 19.76 in 1924. The greater part of the city is lighted by gas, but a start has been made towards the erection of high power electric units on tram routes, the lighting brackets being attached to the existing tramway standards.

The Oxford Corner House

A LIGHTING INSTALLATION ON NOVEL LINES.

The opening of the new "Corner House" of Messrs. J. Lyons and Co. Ltd., on the site of the old Oxford Music Hall, has attracted some attention owing to the unusual architectural features of the building (fully reviewed in a recent issue of *The Architect*). The outside harmonizes with the style adopted for other corner houses established by this firm, but the interior is novel both in design and decoration. An unusual feature is the series of dwarf columns with somewhat curious "mushroom" heads and the ingenious marble decorations, especially the landscape effect incorporated in the design on the first floor. The lighting is effected mainly by "lotus flowers" of translucent glass which fringe the columns just below their mushroom extremities, with the result that the lighting is partly direct and partly indirect. Each of these singular fittings, which are 8 feet in diameter, accommodates 24 100-watt lamps. The system makes possible arresting colour effects. Another interesting feature is that the ventilating system is concealed by the lighting units.

Opportunities for Floodlighting

The variety of uses to which floodlighting is now being put is exemplified in a recent contribution by Mr. A. H. Smith to the *Electrical World*. The illumination of the lofty Wrigley building in Chicago is familiar, but the treatment of the long Soldiers' Field Colonnade in the same city—quite a different type of building—is equally striking. The other examples include a soldiers' memorial, a bank building, and "an interesting old landmark" (a windmill) in Mount Emblem Masonic Cemetery. Perhaps the most novel departure has been the floodlighting of a new theatre in Seattle whilst in course of construction. It is contended that the scheme was quite justified as an advertisement. Curiosity led many people to the spot, and before the theatre opened its position had become established in the minds of citizens. Floodlighting, however, is not being used only for purposes of publicity. The erection of floodlights on lofty towers has become quite a familiar method of lighting railway yards, quarries, docks, etc., and of facilitating night work generally. In the words of the author, it has made possible a "24-hour day"—an important consideration for many forms of constructional work where speed is of vital consequence.

Photo-Electric Cells in Photometry

An example of the useful research work proceeding in various laboratories in the United States is afforded by the series of papers on photo-electric photometry in the April issue of the *Transactions* of the Illuminating Engineering Society, U.S.A. Those interested in this somewhat abstruse problem may be recommended to consult this series of papers, which contain many useful hints. The necessary precautions may appear somewhat formidable. The paper by Dr. C. H. Sharp and Mr. E. D. Doyle is particularly illuminating in showing the patience that has to be exercised to guard against extraneous disturbing influences. But the results seem encouraging and the photo-electric cell has been applied successfully in quite a wide range of laboratory work, including the taking of polar curves of light distribution. Apart from difficulties arising through varying sensitiveness of cells, one of the greatest obstacles in many forms of photometric work is that the response of the cell throughout the spectrum is widely different from that of the human eye. It appears, however, that this difficulty may be overcome by the aid of correcting filters. We are still some distance from the ideal of a portable illumination-photometer based on the use of a photo-electric cell, and thus eliminating the photometric comparison which is so troublesome to many non-technical people. The chief limitation here is the minute electric effects that have to be utilized. But even this aim may be attained in course of time. Success would result in a great advance towards the popularization of measurements of illumination.

A Pioneer of Electric Lighting

A link with the past has been severed by the recent death of Mr. J. Moffat, one of the oldest employees of the Edison Swan Electric Co. Ltd. Mr. Moffat had been been in the service of the Company since 1881. He was concerned in the equipment of Gatti's Restaurant in the Strand (the beginning of the Charing Cross, West End and City Electric Supply Co.), the Adelphi Theatre, and many early installations, and he fitted up the houses of several of the directors, including that of Sir Joseph Swan.

Decorative Lighting

Monsieur M. Matigot, in *Lux*, puts in a plea for the study of architectural illumination, recalling the pleasing displays of light and colour arranged some years ago at the Exposition des Arts Decoratifs. Architecture has need of light. Has not the Parthenon itself been described as "Light in Stone"? In France, State recognition of the use of light for decorative purposes is implied in the official illumination of certain public monuments. The use of light for the illumination of buildings is also extending, and several typical examples of floodlighting are reproduced. M. Matigot emphasizes the importance of studying each case on its merits; not only the reflecting power of the surface but its architectural features should be considered. The same idea of using light for decorative effects is taken up by M. Wetzel in discussing the lighting of the home. Some of the expedients, the insertion of luminous panels in the ceiling—illuminated friezes, etc.—cannot be regarded as efficient, but they have undoubted decorative possibilities. One also observes efforts to use light for purposes of illumination and as an ornamental element in small fanciful contrivances. Amongst these are the "bibelots," queer little figures, geometrical oddities, etc., in which small lamps are incorporated, and the inconspicuous portable lamps applied to the lighting-up of certain objects (pictures, etc.). We notice incidentally that *Lux* quotes freely recent articles in our journal. We are returning the compliment.

The Lighting of Restaurants

In *Licht und Lampe* Dr. H. Gerhard Schmidt deals trenchantly with the lighting of restaurants, which is sometimes strangely neglected. He gives examples of obsolete fittings which could readily be substituted by modern devices. One criticism which will be sympathetically echoed by many in this country is that, even when the actual restaurant is tolerably well lighted, the illumination of adjacent cloakrooms, etc., is sometimes poor to a degree. Visitors need a good illumination by which to make themselves tidy. Too often one is expected to wash by the aid of a bare dust-obscured carbon filament lamp, and to brush one's hair at a mirror with the light behind one! He shows, as a model, a sketch of a room with diffusing units on either side of the mirror and a well-designed bowl mounted direct on the ceiling. Dr. Schmidt also makes one other suggestion that seems worth consideration—the adoption of a large-scale bill of fare, illuminated from behind and visible from a distance. It might still be necessary to supplement this by menu cards on the tables. But the device would help clients to make up their minds and might save an appreciable amount of time during busy periods, whilst a duplicate, embellished with the name of the restaurant and placed outside, would be helpful in attracting custom.

Society of Glass Technology

Visit to Germany.

An invitation was extended by the Deutsche Glastechnische Gesellschaft to the members of the Society of Glass Technology to pay a visit during May 22nd-24th to Aachen, where they were received by the Mayor. An interesting series of papers, by both British and German experts, was arranged. We notice, amongst these, contributions by Dr. W. E. S. Turner and Mr. B. P. Dudding.

Applied Optics

It is often said that information on applied optics and glass technology is somewhat inaccessible. We therefore draw attention to *La Revue d'Optique*, a French journal which frequently contains interesting contributions on optical problems. The chief item in the issue before us is an analysis by Monsieur A. Perrard of certain lines in the spectrum with a view to their application in metrology. In past issues such topics as the uses of monochromatic light in practical optics and methods of distinguishing natural from artificial pearls have been treated. Incidentally we note that a new review, "*Glaces et Verres*," has recently made its appearance in Paris. This, too, should be worth study.

Portable Lamps in the Home

In this country attempts have recently been made to encourage the use of portable lights in the home, and nowadays wiring schemes are considered inadequate unless they are outlets enabling portables to be used in several positions. In the United States Mr. M. Luckiesh reports that at least six additional portable units in the average home are justified, but that at present the average number in use is about 2.8 per home. It is estimated that there is a potential market for more than 100 million portables—approximately sixteen times the number that was sold last year. If the full output could be realized it would be equivalent to 5 million new residential customers—quite worth the consideration of the central station! Regarded in another way it would mean an average gross increase in revenue per residential consumer of 41 per cent. This calculation is typical of the outlook in the United States, where the advantage to the supply company of efforts to encourage advances in lighting is never overlooked.

Too Much Light?

According to *The Illustrated Carpenter and Builder* Dr. Werner Hegemann, of Berlin, in his recent lecture to the Architectural Association, was somewhat critical of the architecture of his own country. One unexpected criticism was that some modern buildings suffered from excess of light. In the design of departmental stores the demand for abundance of light led to the façades being practically all glass. It had been found, however, that too much light was admitted for the adequate display of goods, and in many buildings the window space was partly blanketed by partitions erected inside in order to keep out the light. In another case the craze for light had resulted in a building with windows where it was quite impossible to clean them, and the elevation presented a mottled appearance of clean and unclean glass.

International Industrial Medical Congress

The fifth International Medical Congress for Industrial Accidents and Diseases is to be held in Budapest during September 2nd–8th. The numerous papers to be presented, mainly by Continental experts, deal with industrial accidents and diseases and seem to be almost exclusively of a medical character. We hope, however, that at some of the future congresses an opportunity will be found to deal with the influence of illumination on industrial safety and hygiene, as has been the case at some of the gatherings in the past.

TECHNICAL SECTION

COMPRISING

Transactions of The Illuminating Engineering Society and Special Articles

The Illuminating Engineering Society is not, as a body, responsible for the opinions expressed by individual authors or speakers.

Daylight, Artificial Light and Artificial Daylight

Their Merits and Drawbacks

By J. S. DOW

(Introduction to the Informal Discussion which took place at the Home Office Industrial Museum, Horseferry Road, Westminster, at 6 p.m., on Tuesday, April 24th, 1928.)

INTRODUCTION.—It is often said that " the light of day " forms the best form of illumination, that the human eye has developed in such a way as to make the best use of daylight, and that natural light ought, therefore, to be regarded as our ideal in artificial-lighting installations. Illuminating engineers, however, are aware that although the illumination derived from an unrestricted white sky may be very advantageous, daylight illumination as received in the average home, office or factory through windows is far from " ideal." Not only is it capricious, varying with the time of day, the season of year and the climatic conditions, but the variation in intensity throughout the average interior is far greater than is commonly realized. The writer's own offices are on the fourth floor and receive relatively good access of daylight. Yet, in one room where the lighting is entirely unilateral, a recent measurement showed that the illumination at 11-30 a.m. (from a white sky) varied from 20 foot-candles on the desk near the window to only 0.1 foot-candle at the spot most removed from the window; and this variation occurs within a distance of approximately 20 feet. Another room receives a small amount of natural light from a light-well at its remote end. Yet even here the illumination varied from 20 to 0.8 foot-candles. Both rooms, therefore, almost invariably need artificial light at points most remote from the window. This instance is mentioned merely to show the limitations of natural lighting, and to emphasize the fact that in practice illuminating engineering often resolves itself into an effort to supplement natural light, besides providing a substitute when night arrives.

For this reason comparisons between natural and artificial lighting are extremely valuable. Even those vocationally concerned with artificial lighting need to study daylight conditions and to understand the drawbacks as well as the merits of natural light.

Comparisons between Natural and Artificial Light.—In making comparisons between the two illuminants one finds traces of two distinct schools of thought. There are some who, regarding daylight as the ideal, suggest that artificial lighting should be an imitation of it. In some cases this outlook has been carried so far as to attribute an alleged deterioration of eyesight to the ever-increasing use of artificial light. Some members may recall a meeting of the Royal Photographic Society some years ago when this matter was discussed. The evils of badly applied artificial light are admitted, and doubtless have a prejudicial effect on vision, leading to visual and nervous fatigue. But the writer has never been able to obtain any satisfactory evidence that a general deterioration in eyesight is proceeding; still less that this is due to the use of artificial light. The latest medical opinion, as expressed by Dr. Holtzmann at the annual meeting of the German Illuminating Engineering Society last year, seems to favour the view that the primary cause of myopia is hereditary—that it arises through inherent physical weaknesses, though it may no doubt be accentuated by persistent " close work," especially if undertaken under unsatisfactory lighting conditions. Evidence of visual defects attributable to bad lighting is difficult to obtain, and statistical data from oculists on this subject would be welcome.

The other school of thought regards artificial lighting as something radically different from natural lighting, possessing the great advantage of being under man's control and capable of much greater variation. Its exponents aim at ultimately furnishing artificial lighting even better than that normally obtained through the access of daylight into buildings—far more constant and uniform, capable of infinite adaptation according to the process it serves, and offering a new field for the creative efforts of the artist. Artificial lighting thus regarded must necessarily develop on lines quite different from natural lighting.

Nevertheless good daylight illumination has valuable characteristics which it may often be desirable to preserve. This leads us to the question that is to form the basis of this discussion: " How far is it desirable to imitate daylight in artificial lighting installations? "

Differences between Natural and Artificial Light.—Before proceeding to consider various types of buildings it may be useful to review the chief respects in which daylight differs from artificial light, as ordinarily applied. Attention has been drawn to one grave defect of lack of constancy, both in regard to time and space, characteristic of the natural lighting of most interiors. The chief advantages are the absence of glare and the soft shadows arising from a white sky, the high intensity and the colour of the light. Moreover, the natural illumination of vertical surfaces is frequently about equal to the horizontal illumination at desk level, which is not usually the case with artificial lighting.

In practice, however, these advantages are less overwhelming than is commonly assumed. The presentation of the familiar curves showing the variation in daylight from an unrestricted white sky throughout the year has given a somewhat exaggerated idea of the intensity of natural illumination in rooms. On the writer's desk, situated close to a big window in a relatively well-lighted office, the illumination at midday during recent rather dull days has not exceeded 20 to 25 foot-candles. This figure receives some confirmation from a paper recently read by Dr. Lux at the annual meeting of the German Illuminating Engineering Society in 1926.*. He finds

* " Ergänzung und Ersatz des Tageslichts durch kunstliches Licht," by Dr. H. Lux.

that daylight illumination in modern factories usually attains about 10 to 25 foot-candles. It seems probable that in many city offices the best value attained during the winter is very much less than this.

The Contrast Effect of the Bright Sky.—Some of these advantages become much less manifest when daylight is not received from a white sky. The writer has found that his desk near the window becomes untenable in bright sunshine, owing to the glare. (Incidentally the best methods of avoiding glare from sunlight, by the use of white blinds, etc., deserve quite as much consideration as the elimination of glare from artificial light.) Again, whilst a white sky cannot be said to be glaring in the sense of causing discomfort, it does operate to the disadvantage of the eye in regard to *contrast*—i.e., the presence of the expanse of bright sky overhead or even of the brightly illuminated surfaces of neighbouring buildings raises the level of the eye in regard to working illumination. Consequently, during the daytime the eye seems to need much higher illuminations than those which usually appear adequate by artificial light. We shall return to this point later.

Differences in the Visible and Ultra-Violet Spectrum.—There remain two qualities of daylight that are probably of great importance; firstly, the nature of the visible spectrum, and, secondly, the presence of a proportion of ultra-violet energy. Even in winter the latter is probably much greater than the minute proportion of such energy in ordinary artificial illuminants. There are some who contend that the excess of yellow and orange in the spectra of most artificial illuminants is harmful to the eye. Whilst there is no need for any alarmist view of this difference, the influence of *quality* as distinct from *intensity* of illumination on vision is certainly a matter that deserves research. This is chiefly a matter for the physiologist, though, as will appear later, there are physical effects which have a bearing on this problem. The importance now attached to the ultra-violet radiation in sunlight must also be weighed in considering the treatment of buildings, such as basement offices, into which the sun seldom enters. As members are aware, special varieties of window glass having the power of admitting the ultra-violet rays of relatively long and medium wavelength have recently been introduced, and their adoption in certain large buildings is said to have had noticeable effects on health.

Requirements of Different Classes of Buildings.—Let us turn now to the brief consideration of various types of buildings which utilize natural and artificial light in varied proportions. We have, firstly, such interiors as picture palaces and theatres, which may be said to rely exclusively on artificial light, the provision of which has profoundly influenced their design. These are doubtless cases where no one would demand a slavish imitation of daylight. The whole charm of the lighting depends on its variety and the art with which lighting effects, pleasing in themselves but differing radically from daylight as regards colour, distribution of light and shadow, are contrived. There are also certain basement premises which require artificial light almost continuously. In the future the question whether such premises should be allowed to be used for office work, especially if young people are employed, may well be raised. The conditions in such cases were recently the subject of allusion by Miss Ellen Wilkinson, M.P., in introducing the "Offices Regulation Bill," which includes a provision that offices shall "be adequately lighted both by day and by night." Would artificial lighting alone, even if entirely satisfactory from the standpoint of vision, be considered sufficient? It is stated that in at least one of the leading theatres provisions for regular treatment of the staff with "artificial sunlight" have been installed, and with beneficent results. Experiments are being made with similar treatment in the case of workers in mines—another class who are deprived of the normal allowance of sunshine. Assuming, as seems possible, that in the future even greater reliance is placed on artificial light than at present, will illuminating engineers be required to include in the equipment provision for a proportion of ultra-violet light identical with that in average daylight? It is not inconceivable that in the future this demand may be made and satisfied.

In passing, it is interesting to record that the Osram Lichthaus, in Berlin, is apparently a building designed solely to demonstrate the use of artificial illumination, and, therefore, without windows. It would be interesting to have fuller particulars of work conducted under such conditions.

Turning now from such exceptional cases to the usual interior which receives more or less natural light during the day, one is struck by the frequency with which natural and artificial light are in use simultaneously. On the one hand, we have such cases as the lighting of the home, where natural lighting is invariably followed by a considerable period of artificial light; on the other, we have the elementary schools, in which the use of artificial light is only occasional. But there is a vast number of interiors, particularly offices in congested city areas, where the access of daylight is almost always inadequate, and where a combination of natural and artificial light is very usual.

In the case of domestic lighting one would scarcely think that many people would desire to make the artificial lighting a perpetuation of daylight. When the day is ended it is a distraction and a relief to turn to a different system. The general preference for a mellow yellow light is deep-seated. Except in rooms where serious work is done, an order of illumination lower than that of daylight is probably justified. Such conditions form a natural bridge from the bright light of day to darkness and complete repose. It is a question for consideration whether it is expedient to attempt to educate the consumer to use very high illuminations in the home, however desirable they may be for carrying on his daily work.

An interesting case is afforded by those interiors in which we have not only to deal with the nightly transition from natural to artificial lighting, but also with the simultaneous use of both systems. Apart from the case of offices, factories, etc., in city areas, we have another notable example in railway stations, where the natural light that filters through the smoke-begrimed glass roofs often becomes inadequate. In all such cases a slight change in climatic conditions—the oncoming of a slight fog or dark clouds—may render artificial lighting necessary at any time during the winter. We have also cases in which we have to deal with artificial light and natural light *in succession*—e.g., in using underground subways or in passing out into the daylight from a tube railway. Can anything be done in such cases to bridge the gap and to render the transition easier?

This question also frequently arises in connection with the lighting of shops and shop windows. Many large stores rely very largely on artificial light during the daytime, and windows are now lighted up at an earlier hour than was formerly the case. It is becoming more usual to illuminate windows during the daytime, especially on dark winter afternoons. In such cases the effect of the artificial lighting is doubtless lessened by the marked difference in colour of the natural and artificial illumination.

The Transition from Natural to Artificial Light.—This leads one to consider first the awkward problem, familiar in most offices and factories, of the "transition period" from natural to artificial light, and particularly the difficulty of working in a "mixed" light. The writer has given some study to this question, and believes that the difficulty is not due primarily to the difference in the spectrum of natural and artificial light, though this may be a contributory factor. The suggestion has frequently been made that some form of automatic indicator should be contrived (e.g., based on the use of a selenium cell) to sound a signal when daylight has become inadequate and artificial light is needed. But it is curious that few data have been published indicating what this limiting value of daylight illumination should be.

The following experience of the writer is interesting in this connection. His desk beside the window receives light from an overhead "Restlight" unit, which is visually similar to daylight, and blends with it sufficiently well for no consideration of colour difference to arise. On several occasions he has taken measurements of daylight illumination on this desk at twilight. He

has usually found that a feeling of uneasiness arose when the natural illumination has fallen to about 8 to 10 foot-candles, which became positive discomfort when about 4 or 5 foot-candles was attained. Momentary relief was obtained by switching on the overhead lighting unit, which brought the illumination up to 7 to 8 foot-candles; but the feeling of dissatisfaction returned as the natural illumination continued to diminish, and it was only after a period of about ten minutes' work under the artificial light alone (when daylight had completely failed) that the eye had become again comfortable. At this stage the artificial illumination was only about 3 foot-candles; yet this appeared fairly adequate.

The conclusion seems to be that one of the chief factors in creating uneasiness during the period of waning daylight is *the progressive diminution of natural illumination.* This difficulty is not overcome even by using supplementary illumination which is visually a match for the daylight. Much of the difficulty in working by a mixed light probably arises from the fact that the added artificial illumination is too low. If general artificial illumination of the order of, say, 10 foot-candles were switched on this would usually serve to " swamp " the psychological effect of diminishing daylight. It might even be expedient to draw the blinds and make an abrupt change to such conditions, even if this occasioned a certain period of adaptation of the eye to the new conditions.

Another factor which doubtless influences the problem of working by " mixed light " is the contrast effect of the bright sky and relatively bright illumination out of doors, which make indoor illuminations appear unduly low. In twilight, with a natural illumination on the verandah of 4 foot-candles, the effect appeared very sombre. On stepping into the office, where an artificial illumination of the same value is provided, the effect was that of coming from relative gloom into great brightness. When one seated oneself at a desk with one's back to the window the illumination of 4 foot-candles seemed satisfactory, in spite of some admixture of natural light. But if one faced the window and could see the building on the other side of the street (still comparatively brightly illuminated by daylight), the illumination on the desk seemed inadequate and the eye returned to a state of distraction.

The Relative Intensity of Illumination Needed by Natural and Artificial Light.—This experience seems to have a bearing on the vexed question whether the natural illumination required for the performance of a certain process is less or more than if artificial light is used. At different times the writer has received surprisingly varied replies to this question. His own belief is that if the eye is exposed to the sky above, or even to external objects receiving full daylight, it requires an illumination considerably higher than that which would suffice with a well-designed system of artificial illumination. The eye is tuned up to an entirely different scale of brightness. (It will be noted that, in the case mentioned above, the eye became dissatisfied with a relatively high actual illumination, 8 to 10 foot-candles, but was ultimately contented with a lower illumination due to artificial light alone.) In attempting to establish a relation between the efficiency of an operation by natural and artificial light it would, therefore, be expedient to arrange that operators did not face the window, so that conditions, in regard to contrast, were not very dissimilar whether natural or artificial light were used.

Having made these remarks, the author still believes that the difficulty of working by mixed lights is considerably lessened if the artificial light is a visual match for daylight. In cases where natural and artificial light are frequently used simultaneously, or where the eye is exposed to both in succession, the question of adopting some form of modified " artificial daylight " deserves consideration. The use of fully corrected artificial daylight, such as that furnished by special glass for very accurate colour matching, would not be expedient for general lighting. Various estimates of the amount of light absorbed by such units have been given, but some tests made by the writer suggest that at present full correction cannot be obtained without a loss of light of the order of 60 per cent. This is prohibitive, except, of course, in cases where very accurate judging of colours is important, and, in addition, the general effect of such lighting would be too " cold " to commend its general use.

But the case of less fully corrected lighting units, equipped with a variety of glass giving a visual match with average daylight and fair accuracy in regard to colour values, is different. The writer is given to understand that in these circumstances the loss of light need not amount to more than about 25 to 30 per cent., and this is confirmed by experiences of other glasses of similar nature. There seems some justification for the adoption of such methods in offices where combination of natural and artificial light is of almost daily occurrence. They might also be applied with advantage in underground subways (as has been done recently in certain subways in Germany), and possibly in railway stations, where part of the equipment in more or less permanent use might be on these lines but would be supplemented by the full uncorrected artificial illumination at night. Yet another possible use for such units would be for the lighting of highways under railway bridges, where a motorist is at present liable to be distracted by the sudden passage from the shadow of the arch into bright daylight.

In the case of shops and shop windows there is also something to be said for the use of modified artificial daylight, in view of the frequent mingling of natural and artificial light. The occasional lighting-up of windows during daylight hours has the advantage that troublesome reflections of bright external objects in the window-glass are rendered less evident. The effect in this respect would probably be even more beneficial if the artificial light were a visual match for daylight. In the case of many shops (florists', drapers', etc.), the resemblance to daylight would also be an advantage in regard to colour matching. The chief drawback would seem to be the somewhat " chilly " psychological effect, even of modified artificial daylight, but this might possibly be counteracted by the skilful combination of modified artificial daylight with uncorrected artificial light.

Influence on Acuteness of Vision.—The debatable question of the relative value of daylight, artificial light and modified artificial daylight as regards acuteness of vision has been left almost to the last. Now that the influence of higher illuminations on industrial processes is being studied, it is time that the question of the effect of quality as contrasted with *intensity of light* should also be examined. The writer's own impression, based on experiments recorded in *The Illuminating Engineer* many years ago, is that one of the most important influential factors in this respect is the chromatic aberration of the human eye. The effect of this peculiarity on the writer's eye is that the effort of accommodation for near work is easiest for the blue end of the spectrum and most difficult for the red end. Consequently if detail is illuminated in turn by pure blue and pure red light the former appears more distinct than the latter, and one is conscious of distinctly less effort in focussing the detail examined. This offers one possible explanation why (apart from consideration of intensity of illumination, diffusion, etc.) reading by daylight is, on the whole, less fatiguing to many people than when artificial light, in which the red and orange hues preponderate, is used. For the same reason the writer is conscious that in reading by the light of a portable lamp equipped with glass furnishing modified artificial daylight there is a certain impression of less effort, and the type appears somewhat sharper than by ordinary uncorrected artificial light. Much doubtless depends upon the eye of the observer. The effect appears to be accentuated in the case of short-sighted eyes. The problem may be likened to that of the use of magnifying glasses in the linking industry, recently studied by Mr. H. C. Weston. In both cases the essential point is the power of focussing the eye, which cannot be aided merely by increasing the illumination.

The influence of colour of light on operations involving " close work " seems to deserve more detailed study. Apart from distinctness of outline, as exemplified in reading type, there is the further question how far the

perception of solid objects is affected. With a pure blue light at close quarters the writer is conscious of greater ease in reading and a certain impression of "restfulness" and "flatness." But possibly such light might prove less effective in cases where objects having a certain depth are handled; for instance, in typesetting by hand—a process on which the Illumination Research Committee has already initiated some very valuable researches.

A consequence of the chromatic aberration of the eye is that in the case of distant vision the effect may be reversed; i.e., the writer finds it possible to focus red light sharply, but is quite unable to focus the blue. The effect is readily demonstrated by examining a lamp filament through cobalt glass, or other similar material which has marked bands in the blue and the red. At close quarters the outline of the lamp and filament is seen quite sharply, but as the eye recedes the filament assumes a red hue and the blue spreads out into a species of fan or haze of light, ultimately becoming merely a blue mist. This effect furnishes one justification for belief that a yellow screen for searchlights, floodlights and motor headlights gives better definition to distant objects. Such screens cut off the blue rays, which, though small in proportion, tend to spread out into a blue mist and impair the sharpness of an object. This effect has some bearing on the choice of colour of light for automobile headlights. It is also not without influence on the use of modified artificial daylight for general lighting; owing, as the writer believes, to the spreading of the blue element a somewhat soft and misty effect is given to the surroundings, which appear in sharper outline when illuminated by uncorrected artificial light.

However, in all such cases the personal element must naturally play an important part. As noted above, the effect seems to be more marked in the case of myopic persons; whereas for "long-sighted" people it may, apparently, be reversed, at least for distant vision.

(In order to illustrate this point Mr. Dow first displayed a lamp screened with cobalt glass, and invited the audience to say whether they saw, as he did, a red filament surrounded by a bluish haze. The majority of those present agreed that this was so, but there were some who did not receive this impression. The experiment was then tried in another way, by exhibiting cards with black lettering on a white ground, illuminated respectively by pure red and pure blue light. The coloured light was obtained from a mercury-vapour lamp which illuminated a cabinet divided into two, one side being screened by ruby glass and the other with blue glass. This experiment gave results in accordance with the former one, i.e., most of those present found that they could see the letters illuminated by red light more distinctly than those illuminated by blue light; but there were some who recorded exactly the opposite impression.)

Architectural Considerations.—From the æsthetic and architectural standpoint there is something to be said for a system of artificial lighting which can be made to blend with the natural lighting and does not appear to be a foreign element. This applies particularly to churches and large interiors in which natural and artificial lighting are simultaneously in use. As a delightful example one might mention the lighting of the new home of the Chartered Institute of Secretaries, which the writer recently visited in the company of Capt. E. J. Halstead Hanby. Owing to its position in the centre of London, the natural lighting of this building almost invariably requires to be supplemented by artificial light in winter, and accordingly bowls and local units equipped with glass furnishing "modified artificial daylight" are installed throughout. The council room is charmingly designed in Gothic style. It receives natural light from inclined skylights, and between these there is a series of large units which have blue-tinted glass bowls below and opal reflectors above. The latter, being high up, blend with the skylight illumination, so that one scarcely regards them as artificial lighting units. The installation is saved from "coldness," however, partly by the small proportion of yellow light which filters upwards and illuminates the ceiling, and partly by the general scheme of decoration, the panels being in oak and

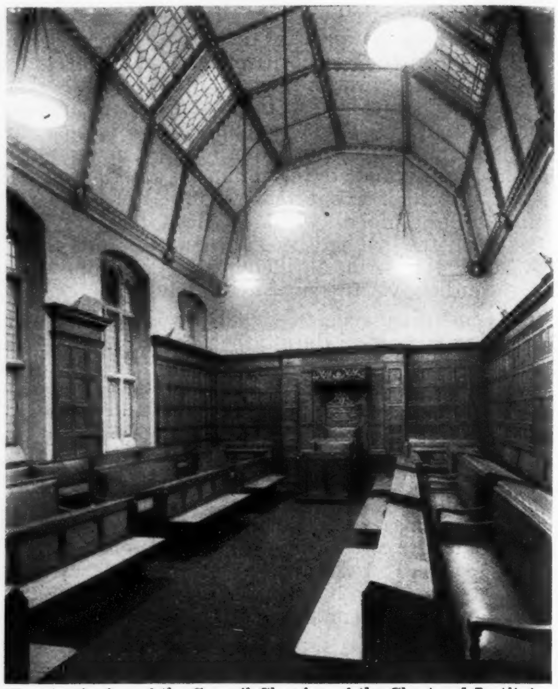


FIG. 1.—A view of the Council Chamber of the Chartered Institute of Secretaries, where the natural light received through windows and skylights is supplemented by "modified artificial daylight."

the seats finished in buff hide. The wall decoration, in gilt and blue, harmonizes well with the lighting scheme.

Psychological Effects.—The psychological effect of light is as yet so imperfectly studied that the writer hesitates to make any very definite assertions in regard to the relative effects on the mind of daylight, artificial light and artificial daylight. Yet there does seem some basis for the impression that the blue end of the spectrum is more sedative and restful, whereas red and orange rays are stimulating and exciting. The modified artificial daylight discussed above is doubtless much less "cold" and "soothing" than is fully corrected artificial daylight. Nevertheless the writer's impression is that a room illuminated exclusively by modified artificial daylight has a distinctly less exciting and stimulating effect than one illuminated by ordinary methods of artificial illumination.

Both psychological effects have their uses. In some interiors one may desire a soothing and restful effect—but this would naturally not be aimed at in a factory aiming at intensive mass production! The writer, on entering a room receiving, say, 10 to 15 foot-candles of uncorrected artificial illumination is conscious of a distinctly exciting effect. It may be, therefore, that the higher outputs generally associated with high illuminations are due partially to this energizing influence, as well as to the fact that operators can see better.

If this is true it raises several interesting questions. Will the stimulus to effort thus secured be permanent, or is it possible that workers exposed to super-illuminations may tend to exhaust themselves, ultimately slowing down to normal production? Again, lighting conditions conducive to greater output may not be helpful to accuracy. A restful and soothing effect might result in somewhat slower but more accurate work—and in some forms of work this would not be a drawback. Such considerations might possibly help to explain cases in which greater accuracy is accompanied by somewhat diminished production, as was apparently the case in some of the experiments with artificial daylight conducted by the Illumination Research Committee.

One might also imagine that the choice of the system of illumination—soothing or stimulating—might depend on the nature of the interior. In general, the more stimulating effect would be preferred in offices and workrooms, shops (where inclination to purchase is effected) and many places of entertainment; whereas, in churches, hospital wards, and possibly in libraries, the more restful effect might be desired.

Finally, it should be remembered that by the skilful combination of artificial light and artificial daylight intermediate conditions may be obtained. The instance of the council chamber of the Chartered Institute of Secretaries has already been mentioned in order to show how a certain tendency to coldness can be counteracted by the scheme of decoration.

Discussion

The CHAIRMAN (Mr. D. R. Wilson), in opening the discussion, intimated that there were several exhibits to be shown. He would, therefore, first call upon the two gentlemen, Capt. E. J. Halstead Hanby and Dr. S. English, who were responsible for these exhibits.

Captain E. J. HALSTEAD HANBY then explained the nature of his exhibit, which consisted of three cabinets, illuminated respectively by artificial daylight, modified artificial daylight (visually similar to daylight, but not sufficiently corrected to be suitable for very accurate colour matching), and uncorrected artificial light. The exhibit was arranged to show the marked difference in the appearance of colours in these three cases, and also the influence on acuteness of vision. He thought those present would agree with him that it was much easier to read the printed matter illuminated by the modified artificial daylight than by the ordinary light of an ordinary gasfilled lamp. It was interesting to note, however, that the fully corrected artificial daylight was not quite so good in this respect.

Capt. Halstead Hanby wished to compliment Mr. Dow on his paper. He found himself in complete agreement with Mr. Dow on many points, and he appreciated his reference to one of the installations undertaken by the company with which he (Capt. Halstead Hanby) was associated. He thought it would be agreed that the methods adopted in this case overcame the two main objections frequently raised against artificial daylight —its " coldness " and the difficulty of meeting æsthetic requirements.

He himself believed that the light by which one worked and used one's eyes should be as nearly as possible akin to that for which the human eye has been adapted by nature. In support of this contention Capt. Halstead Hanby quoted several instances of persons who had suffered considerable physical disability when using ordinary uncorrected artificial light, but whose eyes had completely recovered within a short period when modified artificial daylight was substituted. He also quoted a theory to account for such experiences, based on the belief that people of northern races are weak in the red colour sensation and are adversely affected by excess of red-orange or infra-red radiation. People of these races have frequently grey or blue eyes, whereas brown or black eyes prevail in the tropics. It was even suggested that an appreciable alteration in the colour of eyes had occurred in the case of persons living in cities and making frequent use of artificial light.

He quite agreed with Mr. Dow's estimate of the average daylight illumination in rooms. The general impression of the high intensity of natural illumination was much exaggerated. The figure mentioned, 20 to 25 foot-candles, was certainly the maximum he (Capt. Halstead Hanby) had observed in his own office. In another office the average illumination on a clear day was about 10 foot-candles, and he believed that a minimum of 6 foot-candles of artificial daylight was necessary in order to obtain good visual acuity. Mr. Dow had referred briefly to the benefits resulting from the admission of ultra-violet light through special window glass. The use of such glass had had extremely beneficial effects on animals at the Zoological Gardens, and he believed that its use would prove equally valuable to human beings, and would ultimately result in the elimination of certain diseases (rickets, tuberculosis, etc.).

He agreed that the time when modified artificial daylight was of greatest value was in the transition period from day to night. But he was surprised that Mr. Dow experienced discomfort with a daylight illumination of 8 to 10 foot-candles. He himself had not observed the uncomfortable effect of the progressive decline in daylight. In fact, he had found that after the modified daylight, until artificial daylight was switched on, he had seldom noticed when daylight had failed—and had sometimes missed his train in consequence.

Highly corrected artificial daylight approximating to " north light " was quite unsuitable for general lighting. A loss of 60 per cent., mentioned by Mr. Dow, would hardly enable accurate correction for colour matching to be made. In one of the most widely used artificial daylight units the loss of light was actually about 78 per cent. Apart from this loss of light, the chief objection is the peculiar sensation of " blackness " due to lack of atmosphere, and the inevitable darkening of the upper parts of the room owing to the use of metal casings for the reflectors.

He did not think it would be true to say that it was mainly shortsighted people who would benefit from the use of modified artificial daylight. It was doubtless true that the greater ease of vision was associated with the automatic readjustment of focus. But, as Mr. Dow had remarked, very few people had equal vision; in many cases one eye had a long and the other a short focus, and eyestrain was apt to be caused by the tendency to use the short-focus eye to the neglect of the other. This tendency was obviated by the use of modified artificial daylight. Mr. Dow had raised the question whether artificial daylight would be suitable for processes in which small objects had to be perceived in relief, as in typesetting by hand. He wished that Mr. Riddell, of the London County Council Central School of Printing, had been able to be present at this meeting, as he could confirm that the adoption of the system in that school had led to very beneficial results.

In regard to the effect of light on industrial psychology, surely it was not stimulation, in the sense of excitement, that was needed, but steady concentration of mind. If stimulation were needed it should come from the architectural surroundings, not from the light. He believed that the best colour for the walls of schools or factories was neither green nor red, but a pale lemon yellow.

He was glad that Mr. Dow had emphasized the importance of co-operation between the architect and the illuminating engineer, and he might add that the successful results in the case of the building of the Chartered Institute of Secretaries, mentioned by Mr. Dow, were due almost entirely to harmonious working of this kind.

Dr. S. ENGLISH said that he had been asked to give some details of one of the units Mr. Dow had used to show the effect of what may be called modified artificial daylight or " semi-corrected artificial light." As the method of producing this partial correction was somewhat different from that usually adopted, he thought the exhibit might be of interest.

The idea behind this unit was exactly that which Mr. Dow had put forward, namely, that for many purposes, and especially for close work, a light was required more nearly approaching daylight in quality than that given by a clear gasfilled lamp; perfect correction with its high absorption factor was not advisable, nor was it necessary. It was well known that the difference in quality between daylight and the light from a gasfilled lamp lay in the fact that the latter had a preponderance of the red, orange and yellow rays. The method of correction usually adopted consisted in abstracting this excess of long waves by passing the light through a glass screen or filter. The difference between daylight and electric light might, however, be expressed in another way—namely, that the latter was deficient in the green, blue and violet rays. This view suggested another method of obtaining the desired correction—i.e., the addition to and intermingling of the proper proportions of green, blue and violet with the light emitted by the lamp towards the working plane.

This was accomplished by the use of a reflector-refractor unit, in which a glass screen was placed so as to intercept the upward emitted light before it reached the reflector portion of the unit. This glass screen was of a special composition and transmitted only violet, blue and green in decreasing proportions. This over-corrected light was then reflected in a downward direction on to the prismatic refracting portion of the unit,

where it was mixed with the downward emitted light direct from the lamp.

A further improvement in the quality of the light might be obtained by overrunning the lamp to a small extent, but whether this need be done or not depended on the amount of correction it was desired to obtain.

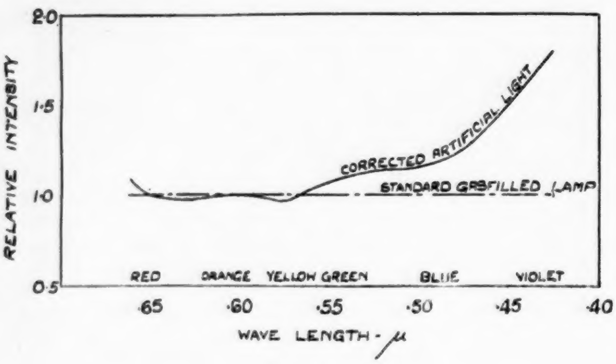


FIG. 1.

That this method of increasing the proportion of green, blue and violet was effective was shown by the diagram (Fig. 1), which showed a curve for "corrected artificial light," drawn from the results of an independent test of this unit. In this diagram the intensities of the light given by a gasfilled lamp in the various zones of the spectrum were taken as unity and shown by the horizontal broken line. The full line represented the intensity of each colour given by the semi-corrected unit. It was clear that the two lights were very similar in the red, orange and yellow regions, but that the modified light was slightly richer in green and much richer in the blue and violet regions.

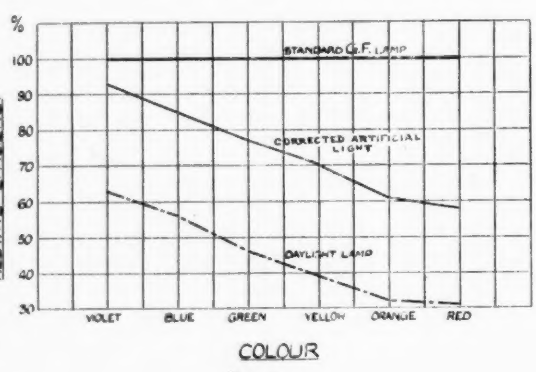


FIG. 2.

In Fig. 2 the relative efficiencies in different parts of the spectrum of various 100-watt lamps when used in the reflector-refractor previously mentioned were shown. A standard 100-watt gasfilled lamp was taken as 100 per cent. throughout (Curve No. 1). Curve No. 2 showed the efficiency in each zone of a 100-watt lamp (5 per cent. overrun) when used with the special glass screen, and Curve No. 4 (broken line) showed the same data for a 100-watt daylight lamp.

In the hands of practical users with whom this unit had been put on trial it had proved very satisfactory. To quote two examples: (1) In a large set of offices which were illuminated by daylight at the sides, but which had to rely permanently on artificial light near the middle, it had been found that the light from this unit blended satisfactorily with the daylight; (2) an artist who used one found that when he had worked by its light during an evening he could carry on with his work next morning without making any alteration to the colours applied by the artificial light.

Mr. C. C. PATERSON expressed his interest in the paper. He was not quite sure, however, that it was right to assume that the human eye had been developed solely with a view to making the best use of daylight. It might quite well be argued that the eye of primitive man had been developed just as much to enable him to see at night. The whole mechanism of adaptation, and the extraordinary difference between the sensitiveness of the eye at night and during the day seemed to suggest that night vision had played a very large part in the development of the eye—probably much more so than the relative small difference in the colour of daylight as compared with other forms of light.

It should be remembered that the average daylight is not in any way a definite quantity. Daylight might well vary in colour from something approaching red and orange to very distinct blue. Natural light, in fact, passed through an enormous range of colour, according to different times of the day and the climatic conditions, so that one might go astray in attaching too great importance to the influence of colour. He was inclined to attribute quite as much weight to the other factors, such as the point mentioned by Mr. Dow, that so far as interior lighting was concerned the illumination in a vertical plane was relatively high. He quite agreed with Mr. Dow that contrast was also a most important factor. In daylight one was accustomed to seeing much greater differences of brightness in the objects themselves than was the case by artificial light, and the retina was in a less sensitive condition.

In regard to Mr. Dow's comments on the influence of increased illumination and the nature of work done, he thought that if Mr. Weston's summary of the work of the Illumination Research Committee was examined it would be seen that the judgment of output was based on an accuracy, and not merely on the total volume of work accomplished.

Mr. Paterson also asked Mr. Dow to explain his suggestion in regard to the influence of colour of light on the visibility of objects illuminated by a motor-car headlight. It did not seem to follow from the experiments shown that the use of a light having a bluish tint was necessarily bad for this purpose.

Mr. J. MACINTYRE thought that too much importance should not be attached to the great variation in natural illumination during daylight hours. He suggested that the case mentioned by Mr. Dow, where the illumination at one end of the room was as low as 0.1 foot-candle, was a rather exceptional one. The defect in such a case surely lay with the design of the building or its locality rather than with natural daylight *per se*.

Variation in illumination in a room was not in itself unpleasant, provided the transmission was gradual and there were no abrupt contrasts. He was inclined to think that the illuminating engineers were apt to attach too much importance to uniformity. In aiming at uniformity they were probably influenced by a desire to avoid inconvenient shadows. The consideration of this factor had led him to become interested in the design of artificial windows and the adoption of lighting panels of a comparative large area in rooms.

The statement that a higher illumination was required by daylight than by artificial light seemed to need qualification. The cases mentioned involved sudden transitions from a high value to a comparatively low one. In rooms where daylight was comparatively poor all day long he had found exactly the opposite. Clerks would sit near the window and work contentedly with an illumination of 1 foot-candle, whereas in the evening when the light was switched on they immediately demanded at least 2 foot-candles. The question of adopting a special glass to transmit ultra-violet light was an interesting one, but there seems to be some doubt in the minds of medical authorities whether sufficient ultra-violet radiation penetrated the London atmosphere throughout the year to make the experiment worth while. Such special glass is necessarily expensive, and it would seem that further investigation was needed.

Mr. Macintyre mentioned that he had been interested in several installations involving methods of supplementing daylight by artificial light. This applied generally to basement and subground floors where only a small part of the working plane is adequately lighted during the day. In such cases he had usually found that better results were obtained from panels, or what might be termed "artificial windows," than from ceiling fittings. The benefit of having a light which blended well with daylight was considerable. He had gone somewhat

closely into the economics of the question. On an average it cost about £20 per man to accommodate clerks in the Whitehall area, the allowance per man being 80 square feet. The value of a similar area as storage space was comparatively small, but if a badly lighted room could be improved by the addition of artificial daylight blending with the ordinary daylight to such an extent that one additional clerk could be housed in it, the amount that could be expended economically per man on lighting was about £15 per annum. Panels had been found to give better results than fittings, probably because the ceilings of the room studied were low. He had been trying to obtain a light blue glass which would imitate daylight sufficiently well but would absorb a minimum of light. With the partial correction aimed at he was usually satisfied that the glass would transmit about 50 per cent.; but if complete correction was aimed at he thought that the loss of light would be nearly 80 per cent.

Mr. L. E. BUCKELL expressed his appreciation of the masterly way in which Mr. Dow had dealt with a somewhat difficult subject. During recent years there had been a good deal of mental confusion on this matter, and he thought that Mr. Dow had put the subject before them in a much clearer way than it had been presented before. The economic aspect, as touched on by Mr. Macintyre, was very important. The cost of ground and of buildings, especially in London, was becoming enormous, and the utilization of buildings which required artificial lighting continuously would have to be seriously considered. Some years ago he had been called upon to look into the extra cost of providing daylight in a large building, and had found that it ran into thousands of pounds. There was no doubt that in such a case the cost of artificial light would be a small figure in comparison.

He thought that Mr. Dow was absolutely right in pointing out that there was no objection to imitating artificial light for domestic lighting. The decision as to what colour should be adopted for artificial lighting depended entirely on the purpose which the light was to serve. He thought most people would agree that if one was not engaged on important work which required fine vision a soft warm light was the best one.

In regard to the influence of colour on acuteness of vision, he did not think that chromatic aberration was the only factor. One other important point was that a light resembling daylight in colour enabled the eye to detect small variations in colour which would otherwise be inappreciable. This was very evident in the case of men working at the lathe with various metals, and tools of which were more or less grey in tint. Their selection of materials was probably guided largely by small changes in hue which might become indistinguishable by uncorrected artificial light.

Mr. Dow referred to the impression of "coldness" when modified artificial daylight was used. He himself had found that if the appearance of blue could be seen in the source of light—for example, if the filament were seen through a bluish glass—then one at once received the impression that the light was cold. But if, on the other hand, the blue element was completely concealed in diffusing fittings, then the same objection did not seem to arise. He thought, in fact, that the effect was mainly a psychological one. Mr. Dow had also referred to the sensation of discomfort when attempting to work by artificial daylight whilst the eye was exposed to the overhead sky. Was not this due simply to the contraction of the pupil to protect the eye from the sky brightness, which caused articles on the desks to appear inadequately illuminated? The same effect occurred when one passed from a brightly lighted area into one which was very much less brightly illuminated.

He was very much interested in the use of large luminous areas, upon which Mr. Macintyre had briefly touched. He believed that this tendency would play an important part in the future of illuminating engineering. During the next few years efforts would probably be made to obtain illumination from surfaces which were themselves of low brightness, but of very great area. Some quite startling results in this direction had been obtained on the Continent and in the United States.

Mr. A. CUNNINGTON referred to three examples of transition from daylight to artificial light, and drew attention to the difference in apparent effect in each case. He cited first the case of a person reading in a train passing into a tunnel from bright sunlight. Here the illumination on the book might easily change suddenly from 2,000 or 3,000 foot-candles to 2 or 3 foot-candles, and yet only a momentary inconvenience was experienced while the eye adapted itself to the new conditions.

The next example mentioned was that of a motorist passing through a long, straight subway or tunnel under a wide railway. Measurements had been made which showed a very rapid falling-off in illumination. At intervals of about 30 feet the following successive readings in foot-candles were obtained: Over 2,000, 20, 2.0, 1.5, 1.0.

A third somewhat similar case was noted of a subway for foot-passengers only, in which the falling-off in illumination is indicated by the following figures in foot-candles: Over 1,000, 65, 3, 0.7, 0.6, 0.42. In this example the end of the subway sloped upwards so as to cut off the daylight that would otherwise have entered through the tunnel mouth; but in the case of the road tunnel one was very conscious of the bright sky visible at the other end, and this appeared to have a striking effect in diminishing the effective visibility.

In comparing these two cases it was an undoubted fact that the ability to discern objects was much less in the first case than in the second, although the actual illumination was more than 100 per cent. greater in this tunnel. Mr. Cunnington thought these three examples served to confirm that the eye can accommodate itself more readily to severe changes in the same kind of light than it can to a mixture of daylight and artificial light. Mr. Dow's suggestion that in daylight the eye is tuned up to an entirely different scale of brightness was confirmed by the effect when entering subways from the street. An artificial illumination which seemed generous at night would appear to be very inadequate when one entered the subway during the day, even though some considerable time had elapsed for the ordinary accommodation to operate by the enlargement of the pupil.

Mr. W. C. RAFFÉ hoped that the council would consider the question of having more meetings like the present one. Although Mr. Dow had explained that the paper was drafted as a stop-gap, he thought that it had led to a very useful and interesting discussion.

He was rather surprised to note, however, that the fundamental question of what constituted average daylight had not been dealt with. Until one could arrive at a definition of this term it was difficult to determine the actual effect on the eye and the bodily mechanism. The reaction of the eye to light and colour was at present very imperfectly understood. It was not always appreciated how much one eye differed from another, and he would suggest that illuminating engineers, before drawing definite conclusions of the effect of coloured light, should have their colour vision tested.

Mr. Dow had mentioned the uneasiness which developed during the change from daylight to artificial light. It should be remembered that when daylight was failing not only was the daylight diminishing but the whole range of solar radiation was likewise being diminished. There was a complete lessening of the reaction which produced activity in all animal life. It was advisable, therefore, not to concentrate one's attention only on the visible rays, which formed only a small part of the whole.

Similarly, one should accept with reservation the suggestion that higher outputs in factories were due simply to the higher illumination provided. There was a higher output throughout the whole plant world when it was subject to sunlight, and the same applied to poultry farms. There seems to be some fundamental explanation of this effect, and that daylight and artificial light alike give vital stimulus to increased action.

One increasing suggestion had been that artificial daylight might be adopted as a form of seasonal lighting during the summer, in order to produce an impression of coolness, whereas in the winter people would prefer the warmth associated with red and orange rays.

Mr. J. L. H. COOPER (*communicated*): Mr. Dow is to be congratulated on presenting such an interesting paper. Although we may not agree with all his remarks, we must admit that he has given us food for thought.

It is interesting to observe that Dr. Lux recently estimated the average daylight intensity in factories to be between 20 and 25 foot-candles. This corresponds closely with the figure ascertained by the writer in his recent survey of engineering workshops, namely, 20.5 foot-candles.

One finds that the psychological effect of artificial daylight varies considerably with individuals, and much depends on the manner in which the light is applied and the purpose it serves. I was informed by the manager of a large chocolate factory, employing bench daylight units in the sorting room, that when these were first installed many complaints of the coldness of the light were at first received from workers; but after a month's experience these complaints ceased entirely, and, to his surprise, he was requested to light the whole room by artificial daylight!

Again, in a certain drawing office it was found that one section utilized ordinary lighting, whereas another employed daylight lamps, though both sections were engaged on similar work. In this case some of the draughtsmen preferred artificial daylight, whilst the others did not like the idea of working under it. One other example might be mentioned—a commercial studio—where the usefulness of artificial daylight outweighed its psychological effect. The work in this studio was greatly restricted under ordinary artificial light, and artificial daylight was ultimately adopted in view of its advantages for this kind of work.

For some manufacturing processes, such as those in the clothing and textile industries, fully corrected artificial daylight seems essential; but most commercial requirements can be met by semi-corrected light (modified artificial daylight). There are many industrial establishments, such as plating works, where this form of lighting has manifest commercial advantages, irrespective of any psychological influence it may have.

Mr. H. E. HUGHES (*communicated*): Daylight illumidation on a desk in my office, where the ceiling and windows are high, may attain 100 foot-candles on a cloudy day. In the case of poorly lighted offices the use of rippled or prismatic glass for the upper parts of windows may help very considerably.

The transition from daylight to artificial light may be aided in another way—by making daylight conform to the colour of artificial light! This can be readily done by furnishing windows with a narrow border of amber glass, leaving the central region clear. Perhaps one-eighth of the whole window area might be thus coloured. One installation of this type which I have in mind has answered very well. There is no noticeable transition from natural to artificial light, but always a cheerful sunny effect through the windows, which blends with electric lighting so long as daylight lasts.

As regards the psychological effect of artificial daylight, I may mention that a theatre manager, actuated by a desire for novelty, recently installed daylight lamps under the glazed roof that protected his outside queues. Two nights' experience was long enough to establish the "coldness" of the effect. The blue lamps were replaced by flame-tinted ones, and the queues again expanded to their normal volume.

Mr. J. S. DOW (in reply): In the first place I wish to express my appreciation of the kind reception given to the paper, which, as explained, was prepared at somewhat short notice. The exhibits, kindly arranged by Dr. English, Mr. E. Stroud and Mr. Allpress, and also by Capt. E. J. Halstead Hanby, added greatly to the interest of the discussion, and our thanks are due to them for their help.

I notice that the latter and Mr. Cooper both confirm my impression of the intensity of daylight illumination usually found in offices; whilst it is doubtless true, as Mr. Hughes mentions, that illuminations as high as 100 foot-candles are sometimes met, I think that about 20 foot-candles is a usual maximum, at least during the winter. The sense of discomfort in waning illumination may, as Mr. Raffé suggests, be partially due to the diminution of all forms of solar radiation; in the case of a total eclipse the rapidity of the change makes it very impressive. Although Capt. Halstead Hanby is unaware of this sensation, provided adequate illumination is provided, it is, I think, a general one, though, as suggested in the paper, the period of awkwardness is greatly shortened if the artificial illumination is a match for daylight, and is sufficiently high—say not less than 5 to 10 foot-candles. Both Capt. Halstead Hanby and Mr. Macintyre agree that fully corrected artificial daylight cannot be secured without a loss of light of the order of 80 per cent. My estimate of 60 per cent. was intended to be a minimum. It is quite possible that extreme accuracy involves an even greater loss. This emphasizes the point that, on the ground of efficiency alone, fully corrected artificial daylight is unsuitable for general lighting. Dr. English's exhibit was most interesting, and shows that there are alternative methods of getting the daylight effect. I would suggest, however, in general this method should be pursued without overrunning the lamp, which introduces a factor of uncertainty.

I quite agree with Mr. Paterson that in view of the fluctuations in the quality of daylight, too much importance should not be attached to colour. But, taking daylight conditions as a whole, the variations in colour of natural light are doubtless small in comparison with the difference between average daylight and most artificial illuminants. I know that, as Mr. Raffé remarks, the absence of any satisfactory definition of "average daylight" is a weakness. But the problem is a difficult one, which has so far defied the efforts of many much better able to deal with it than myself.

On the whole, I am inclined to agree with Mr. Paterson that the most important respect in which daylight differs from artificial lighting is in the contrasts afforded. In this connection Mr. Cunnington's experiences in the lighting of tunnels are most instructive; they seem to bear out completely my impressions of the chief source of difficulty in working by "mixed light."

I do not think that the variation in illumination in the office mentioned in my paper (from 20 to 0.1 foot-candles) is unusual for a room which receives unilateral lighting. The uniformity could doubtless be improved by the use of prismatic glass. As Mr. Macintyre points out, the variation in daylight illumination in passing on from one side of a room to another is not in itself very troublesome, provided the transition is gradual. But it is evident that, with a variation such as that mentioned above, the illumination in parts of rooms most remote from windows must often be far below that necessary for comfortable work.

Mr. Macintyre and Mr. Buckell both refer to the use of "artificial windows," i.e., surfaces of low luminosity but large area, which may play a more important part in lighting schemes of the future. This method has great possibilities, especially from the decorative standpoint. Probably it will also help to complete the illusion that the artificial light is natural lighting. But in using panels and artificial windows one should be careful to avoid the usual drawbacks of natural lighting—i.e., to distribute the panels so that the illumination of the room has not the extreme variations that arise when daylight enters from one side only.

In regard to the comparative effect of artificial light and natural light on acuteness of vision, it seems probable that chromatic aberration of the eye is usually the most important factor, though, as Mr. Buckell suggests, distinction between shades of colour also plays a part. The experiment at the meeting was intended to show the variation between different eyes and the importance of the "personal factor," though I am inclined to think that the majority of eyes resemble mine in finding the blue end of the spectrum difficult to focus at a distance, but easier to focus for very close vision. Assuming that this is the case, the suggestion that blue light is inadvisable for motor-car headlights, to which Mr. Paterson referred, would naturally follow. But here again some eyes might receive exactly the reverse impression to that received by my own.

POPULAR & TRADE SECTION

COMPRISING

Installation Topics—Hygiene and Safety—Data for Contractors—Hints to Consumers

(The matter in this section does not form part of the official Transactions of the Illuminating Engineering Society; and is based on outside contributions.)

Light and Visibility

By W. J. JONES, M.Sc.
(*E.L.M.A. Lighting Service Bureau*).

PART I

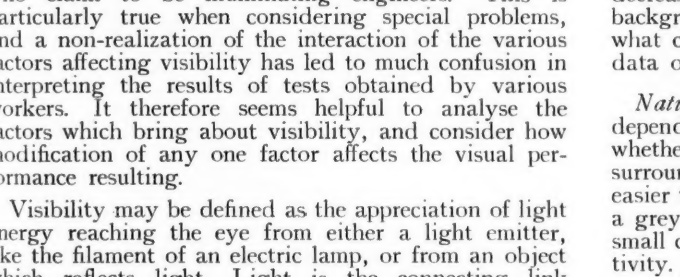
INTRODUCTION.—There is an increasing tendency among lighting engineers to consider good illumination as merely the provision of a given intensity of illumination on the plane of work, and while this is perfectly sound in the majority of instances it is important that some of the underlying principles of light and visibility should be appreciated by those who claim to be illuminating engineers. This is particularly true when considering special problems, and a non-realization of the interaction of the various factors affecting visibility has led to much confusion in interpreting the results of tests obtained by various workers. It therefore seems helpful to analyse the factors which bring about visibility, and consider how modification of any one factor affects the visual performance resulting.

Visibility may be defined as the appreciation of light energy reaching the eye from either a light emitter, like the filament of an electric lamp, or from an object which reflects light. Light is the connecting link between the eyes and the object seen, and the clearness and exactness of vision afforded will vary in large measure with the nature of the lighting. The eye can be likened to a wireless receiver which is tuned to respond to electro-magnetic radiation of wavelength between 16 millionths of an inch (violet light) and 32 millionths of an inch (red light). According to the wavelength of the light which reaches the eye, so we experience colour. The shorter wavelengths correspond to blues and violets, while long waves give us the sensations which we call orange and red, and intermediate wavelengths give green, yellow, etc. When the light is of a mixed character, i.e., of all wavelengths, the eye experiences white. It should be remembered at the outset that the only appreciation which the eye has is of colour contrast and brightness contrast, or both, and, according to the varying degrees of contrast afforded, so we make interpretations as to the nature of the objects which surround us. The amount of light available materially influences the facility with which this contrast can be perceived, and often, of equal importance, light can be controlled to increase or decrease the contrast provided by the object and its background. The inter-relation of these facts is somewhat complex, and it is difficult at times to correlate data or place it in proper perspective.

Nature of Object Viewed.—Visibility obviously depends largely on the nature of the object itself, whether the amount of contrast it affords with its surroundings is large or small. For instance, it is much easier to see a black object on a grey background than a grey object on a grey background. Fig. 1 shows a small cut-out pasted on backgrounds of different reflectivity. The contrast afforded may be due to the background being lighter than the cut-out, and the figure stands out in silhouette (as in the example on the left), or due to the background being darker than the cut-out. The former is by far the more common in our visual operations; for example, dark ink or print on white paper, or visibility along a street where an individual stands out in silhouette against the light background of the thoroughfare.

A certain proportion of the light falling on the object is reflected and enters the eye, and a certain proportion of the light falling on the background enters the eye, and the difference between the brightness of the object and background is a determining factor in the distinctness with which the object is seen. In the example quoted in Fig. 1, if we assume that an equal light

REFLECTION FACTOR OF CUT-OUT, 28%.



84% 55% 39% 28% 20%

Reflection Factors of Backgrounds.

FIG. 1.—Illustrating contrast afforded by relative reflection factors of object and background (grey).

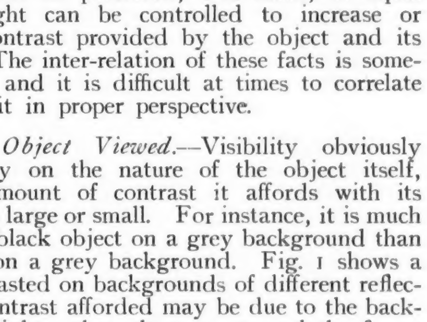


FIG. 2.—Three pieces of wood lighted from one side. The directional nature of the lighting provides the necessary contrast for estimating the shape.

intensity falls on both cut-out and background, then the relative reflection factor can be considered as giving the relative brightness, since brightness (in candles per square foot) =

$$\frac{\text{Incident light f.-c.'s} \times \text{reflection factor}}{\pi}$$

For instance, the ratio of the brightness contrast of a black cut-out on a white background can be considered as 90 : 3, where 90 per cent. is the reflection factor of the white background and 3 per cent. reflection factor of the black cut-out. The ratio is therefore 30 : 1, and this represents the limit of contrast which can be obtained under ordinary conditions in offices and workshops. The degree of contrast can, however, be vastly increased by permitting all the light to fall on either the background or the object. For example, much greater contrast is afforded when the background only is lighted up, and hardly any light at all reaches the object. In order that this may be possible the object must obviously be removed from the background in some wav so that the source of light is behind it; alternatively, the background may be of some medium, such as opal glass, which can be rendered luminous. In either case a contrast brightness ratio running into 1,000 : 1 can be obtained. Brightness contrast also enables the eye to appreciate the size and shape of solid objects, the latter largely due to the gradation of brightness (of shadows). Fig. 2 shows three pieces of wood lighted from one side. The shape of each is known to us because we are familiar with the gradation of brightness peculiar to each shape. In this instance the directional nature of the lighting provides the necessary contrast for estimating the shape. In certain works operations this factor becomes very important, and it is desirable to avoid complete diffusion of light.

Contrast, therefore, can be provided by one of four ways:—

1. Colour of object and background.
2. Relative reflection factors of object and background.
3. Lighting only object or background.
4. Gradation of shadows produced on solid objects.

How much contrast is desirable to produce good visibility? Under special conditions the eye can just appreciate a 2 per cent. difference in contrast; the contrast for reading may be 30 to 1 and prove comfortable, while the naked filament of an electric lamp, some 50,000 times brighter than its surroundings, becomes a source of irritation and annoyance. We will discuss this further at a later period when we endeavour to correlate some of these matters.

Size.—It is much easier to see a fairly large object than a small one, and the eye, when endeavouring to focus very small objects, experiences fatigue and becomes relatively insensitive. It has been suggested that the smallest object which can be perceived subtends an angle of 1 minute of arc (that is, a halfpenny viewed at 100 yards subtends an angle of 1 minute of arc), and that the size of image produced on the retina is just sufficient to effect one unit of the retinal system (rods and cones). To perceive a small object, a greater contrast brightness is necessary for the same facility of seeing compared with that of a larger object, and it is also known that the resolving power of the eye, or its ability to perceive fine detail, is a function of the amount of light available.

Summary.—Visibility, from the point of view of the object, can be summed up as depending upon its size and the brightness contrast afforded.

The "Lindberg Light"

The new "Lindberg Light," which it is proposed to erect at the top of one of the highest skyscrapers in Chicago, promises to be an exceptionally powerful one. The beacon will have a lens 63 inches in diameter, and will be mounted at a height of 610 feet above the sea-level. It is expected that it will be visible to aviators at a distance of 250 miles.

The Seventeenth E.L.M.A. Design Course

The photograph below was taken during the seventeenth Illumination Design Course, organized by the E.L.M.A. Lighting Service Bureau, to which reference was made in our two preceding issues.

A Group of those attending the Seventeenth E.L.M.A. Design Course, which has been proceeding during the past month.

We understand that the course has fully justified expectations, and was attended by about 70 engineers representative of all sections of the electrical industry. It will be recalled that the course this year has been of a somewhat novel character, a feature being the incorporation of numerous demonstrations of a novel character, which were much appreciated by those present. The series of lectures covered a wide ground, and was of a more advanced character than hitherto.

Two Interesting Effects of Light

Two special effects of light, illustrating its influence on animal and vegetable life, are reported in the *Transactions* of the Illuminating Engineering Society (U.S.A.).

The first of these is the growth of "superwheat" without either soil or sunlight, which has been announced by the University of California. Exposure to electric light and jars of water containing plant food elements was the secret of its growth. Wheat under field conditions often requires five months to mature. The quality of the wheat raised in these experiments is said to have been much finer than that attained under normal conditions, and justifies being described as "superwheat."

The wheat was grown in a greenhouse laboratory furnished with 12 lamps, each of 300 candle-power. The wheat was grown to maturity in 13 weeks, an unprecedented achievement illustrating the important influence exercised by light on the progress of development. The light was applied during 16 hours *per diem*. When the light was applied continuously for the full 24 hours the growth was even more remarkable.

The second effect was the use of light in connection with certain experiments on fish breeding, now in progress at Cornell University. The fishes used were the "playfishes" which came originally from the region south of Mexico City. They are kept in small aquaria heavily planted with the water weeds which maintain the purity of the water. But the purifying capacity of the plants is directly dependent on the amount of light which they receive, and it has therefore been found essential to supply extra amounts of light during the short days of northern winter.

These two experiences show what a wide field for experiment exists in connection with the influence of light on life of all kinds. It is now some years since the influence of strong artificial light in accelerating the development of fruit and flowers was demonstrated, and, as is well known, artificial light has also proved a valuable element in assisting the well-being of animals from tropical regions at the Zoological Gardens.

Philips Demonstration Rooms in Amsterdam

AN interesting event, on April 30th, was the inauguration of the Philips lighting-demonstration rooms at Amsterdam. Hitherto the company has had no offices in the capital of the Netherlands, all business being dealt with from the main offices at Eindhoven. The number of people visiting Eindhoven was not deemed sufficient to justify establishing any lighting demonstration room there; but various circumstances, including the growing importance of the wireless business, have rendered radio-demonstration and radio-service centres essential at Amsterdam. This led to a combination—rooms devoted both to radio demonstrations and lighting in an old private living house on one of the famous canals, the "Heerengracht."

On these premises (No. 270) there existed an old dining room of considerable dimensions (33 feet by 33 feet), which was considered a suitable lecture theatre to seat about 80 people. This hall is provided with a wonderful stucco ceiling, in Louis XIV style, dating from 1740. The architect for Messrs. Philips (Mr. Kalff) made a special effort to keep this ceiling untouched in order to bring out the beauty of all details by an appropriate system of lighting.

As the picture shows, indirect cove-lighting was selected on two sides of the room, the third side (not visible in the picture) being provided with a pressed-glass cove for semi-indirect lighting, produced by Sabino, of Paris. Visitors, when seated, face two show windows, which, however, can if necessary be concealed by curtains acting as a background for two blackboards. The lecturer's desk is on the right side of these show windows (when not used it is decorated by a huge pressed glass Sabino bowl). The left show window in the picture shows a decoration by Siégel, one of the most modern French manufacturers of requisites for show windows. The show window on the right hand contains a four-fold revolving stage in which demonstrations on light and shade, colour lighting, etc., can be given, but which can also be used for presenting demonstrations of lighting in the home or in show windows.

Above these show windows four panels are provided for demonstrating the use of light for purposes of publicity. The picture shows only two of them equipped. A projection screen can be let down between these two signs and the large aperture, which is provided for a ventilating system with exhaust fan.

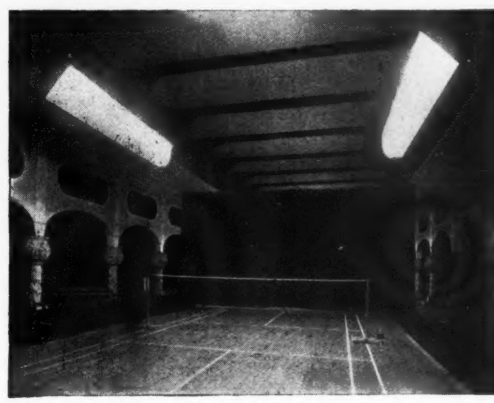
In view of the extent of the lighting installation—there are 450 lamps with an aggregate consumption of 15,760 watts—good ventilation was considered a prime necessity, and special attention has been paid to this requirement. The two sides of the hall have each eight rows of booths for individual demonstrations, experiments and displays of fixtures. The total length of the wiring (2.5 miles) and the length of the tubing (1,100 yards) as well as the number of switches (255)—all of the Hart and Hegeman tumbler type—give an idea of the completeness of this installation.

There are also some small adjacent rooms equipped for various special demonstrations (home lighting, etc.)

The architectural side of lighting is predominant in this demonstration room, and industrial lighting and appliances needed therefor have received less attention than is usual in such demonstration centres. But it should be mentioned that a series of special industrial lighting demonstrations will be provided during this summer in the Museum of Safety. Light in relation to architecture is at the present time one of the most promising aspects of lighting, and the illustration of this aspect on a large scale is specially adapted to create public interest in illumination.

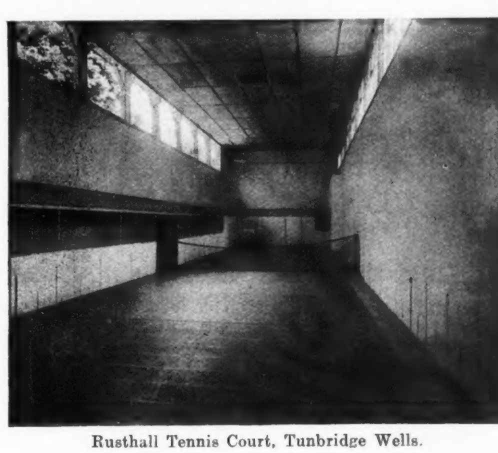
Badminton and Tennis by Artificial Light

The artificial lighting of lawn tennis courts has recently been the subject of much study. Another opportunity for artificial light is the illumination of indoor cricket pitches, permitting practice during the winter. The two accompanying illustrations, for which



Crystal Palace Badminton Court.

we are indebted to the courtesy of the General Electric Co. Ltd., refer to the lighting of a badminton court and a "real" tennis court. For the former a series of 150-watt white Osram bowl-sprayed lamps were mounted in flat reflectors 10 feet long, 20 feet above the side lines. For the tennis court 1,000-watt lamps were



Rusthall Tennis Court, Tunbridge Wells.

mounted in special reflectors so placed and designed that when players are facing the net their eyes are not affected by the brightness of the units. This system affords an illumination of about 25 foot-candles.

A feature of both installations is the manner in which the light is directed from the *side*, and lighting units are kept out of the direct range of view of the players.

A New Note in Restaurant Lighting

ORIGINALITY is the keynote of the new Oxford Corner House lighting scheme. The chief feature of this new form of lighting lies in its adaptation to the decorative scheme of the interior—a result of concerted efforts on the part of the architect, the decorator and the lighting engineer. The observer at once recognizes that the lighting units here installed form an essential part of the decorative treatments. They are of the same design as the artistic pylons which form their anchorage, and the stately marbled wallscape scenery by which they are surrounded.

The restaurant at present consists of two floors. On the ground and first floors considerably over 100 lighting units are installed. Some of the fittings are nearly 25 feet in circumference. They consist of no less than 14 distinct shapes and sizes, but all take the form of a lotus flower, fashioned of gilt metalwork and glazed with a special form of diamond raindrop clear glass relieved by flesh-colour tinted panels suggestive of the petals of the flower, and harmonizing with the rich warm tones of the marble walls and pylons.

The ventilating system of the restaurants incorporated in the lighting fittings has been very carefully designed, and is perhaps as unique a feature as the units themselves. Ventilating ducts are installed above the fittings on the isolated pylons and the majority of the major and minor wall pylons, the louvres at the base of the fittings concealing the openings around the columns leading into the ducts, the lower ones being removable to allow access to the regulator control gear.

The installation on the ground and first floor of the restaurant consists of a double row of isolated pylon lighting units running the whole length of each floor (see Fig. 1). These giant lighting units are octagonal in shape, with English gold-leaf and lacquered metalwork, and fitted with diamond raindrop glass. They surround the marble pylons, shedding their light rays in every direction without shadow or distortion. Each unit is 8 feet in diameter, and four 6-foot men could lay concealed within and around the circle comprised by the lighting unit. Each of these isolated main pylon units houses 24 100-watt Pearl Osram gasfilled lamps. They are supplemented by two forms of pylon units, which are installed along the entire length of each wall, and known as major and minor wall pylons (see Fig. 2). A number of pleasing corner pylon units to match the wall units are also installed.

The major and minor wall pylon units vary from 6 ft. 8 in. to 3 ft. 2 in. in diameter, and are equipped with Osram gasfilled lamps, which are colour-sprayed with a flame tint to give warm light tones, blending with the coloured marble columns and marble wallscape pictures.

FIG. 1.—View of the new Oxford Corner House, showing isolated lighting Pylons with Lotus flower units.

The centre fitting over the doorway of the screen that separates the ground-floor restaurant from the main-entrance shop on the Oxford Street side of the premises is possibly the most picturesque of all the fittings installed in this restaurant of magnificent light. This is 14 ft. 6 in. in length, equipped with Osram colour-sprayed flame-tinted 100-watt lamps, and of imposing appearance. Altogether about 4,000 Osram lamps are installed. The General Electric Co. Ltd. manufactured and supplied the whole of the decorative electric-light fittings for the public rooms and staircases to the designs of and in collaboration with Mr. Oliver P. Bernard.

FIG. 2.—Another view, showing lighting units of similar design at the side.

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A Striking Gas Exhibit at the Building Exhibition

ONE of the most practical and beautiful exhibits at the recent Building Exhibition held at Olympia was that designed for the Gas Light & Coke Company (see Fig. 1) by Mr. Walter Tapper, A.R.A., President of the Royal Institute of British Architects.

One section showed how the costly chimney breasts of bygone days are being dispensed with in new houses, and additional air space provided in the rooms by building at the outset special flues for gas fires in the thickness of the walls. These flues are made of concrete, and cost much less to instal than the brickwork of the ordinary coal fire. That they are practicable was admitted by a large number of the principal London builders and architects who paid a visit to the exhibit. Several gas fires with surrounds (commonly termed "builders' sets") were shown, and the gas fires were hinged so that they could be swung out to enable the flues to be examined. Samples of the special flue blocks, terminals, etc., recommended were also shown, and above them was placed a series of five large drawings by Mr. Walter Tapper, A.R.A., P.R.I.B.A., indicating effective methods of forming gas fire flues in houses and overcoming some of the common problems which arise in their construction. These drawings were perfectly lighted by concealed gas lighting units. The drawings were reproduced in an artistic brochure containing descriptive matter prepared by Mr. Tapper for the guidance of builders. In his notes he pointed out that "many architects and builders have have now discovered that, in the design and construction of labour-saving houses, economies in building costs can be achieved by arranging at the outset for gas fire flues to be provided instead of the 9 in. by 9 in. coal flues.

"Existing by-laws (based on natural laws) enforce the correct construction of coal fire flues, and these by-laws are familiar to everyone connected with building. At present there are no by-laws relating to the construction of *gas fire* flues, and there remains some ambiguity regarding the natural laws which govern their construction.

"*The natural laws which govern the construction of coal flues govern also the construction of gas fire flues.* There is, however, a fundamental difference between gas and coal as a fuel, and this affects the size of the flues necessary. Coal produces soot. Gas, on the other hand, is a clean fuel, and in ventilating it the flue area can therefore be made much smaller than that of the coal flue. A gas flue can in fact be made so much smaller that, by using special economy flue blocks, it can be constructed within the thickness of the party or external walls, rendering unnecessary the provision of a brick breast, and so providing additional floor and breathing space. Further, the concrete hearth of the coal fire can be dispensed with in the case of the gas fire, making trimming unnecessary. In these ways both material and labour costs can be appreciably reduced.

"*Design and Construction of Flues for Gas Fires.*—In the absence of by-laws, the following notes should provide a useful guide to all engaged in the design and construction of gas fire flues:—

1. The cavity of a hollow wall must not be used as a flue for gas fires unless a suitable shaft is properly constructed therein. If smoothly finished, the size of the flue for the smallest gas fire need not exceed 20 square inches in area.
2. All flues for built-in gas fires must discharge into the outer air above the *main ridge* of the roof.
3. Each gas fire must have its own independent flue which throughout its entire length must not be connected with, nor run into, any other flue.
4. The flue may be constructed in either brick or concrete block. Parging is not necessary, but the interior should be carefully trowelled and kept clear of all mortar droppings.
5. The gas fire should not discharge immediately into the flue shaft, but an opening rather greater than the full width of the fire outlet

By the courtesy of "The Gas Journal."

FIG. 1.—The striking Exhibit of the Gas Light & Coke Company at the recent Building Exhibition. Attention may be drawn to the concealed gas lighting of the diagrams on the wall and the pleasing silk-shaded units overhead.

should be gradually (not abruptly) gathered over (as is done in the case of a coal fire), providing a products-of-combustion chamber above the gas fire outlet corresponding with the smoke chamber, which is always constructed above the coal fire.

" The minimum permissible flue area for each size of gas fire, and the approximate floor area of an apartment of average height for which each size of fire is suitable, are given in the following table:—

Number of Radiants.	Size of Fire Front.	Minimum Permissible Flue Area.	Floor Area of Room.
5 and 6	8 in.	20 sq. in.	100 sq. ft.
7 and 8	10 in.	24 sq. in.	150 sq. ft.
9	13 in.	30 sq. in.	200 sq. ft.
10	14 in.	36 sq. in.	225 sq. ft."

airing clothes. The gas wash-copper in the kitchen provided hot water, not only for clothes-washing purposes but for baths. In the latter case, the pan was filled with water and the gas burner was lighted. When the water was heated up the water tap above the boiler was again turned on. Water from it then flowed into the bottom of the pan, and the hot water in the pan overflowed and passed along the pipe into the adjoining bath.

Another feature of the exhibit was a working model of the smokeless house, showing the system of heating it by hot-water radiators and radiant gas fires. By a clever arrangement of transparent glass piping and lighting effects, the circulation of hot water throughout the house was effectively demonstrated. The whole of the Gas Light and Coke Company's exhibit was perfectly lighted. On the outside were 14 handsome lamps of

By the courtesy of " The Gas Journal."

FIG. 2.—The Stall of the South Metropolitan Gas Company at the recent Building Exhibition. Distributed round the walls is a series of beautiful gaslighting brackets, with a shell-shaped shade of attractive design. (These shades were also illustrated in the April number of *The Illuminating Engineer*.)

Mr. Tapper finally suggested that by-laws governing the construction of gas-fire flues are desirable, and that this was a matter which the Ministry of Health might advantageously take up.

The centre of the exhibit consisted of a lounge in blue and gold, with two beautiful gas fires, one in antique brass and the other in antique copper—both with massive marble surrounds.

The third section of the exhibit contained two sets of gas equipment suitable for the kitchens of houses costing respectively under and over £1,000. In each of the kitchens gas provided means for cooking, water heating, washing and ironing. In the smaller kitchen coke was also used for water heating, and in the larger kitchen gas was used for operating a refrigerator and drying and

Florentine pattern in bronze and cathedral glass. Inside ventilating gas lamps were used, and were totally enclosed by silk shades in designs and colours which harmonized well with the general scheme of decoration. Special ceiling holders, with bayonet fittings, were used to hold the ceiling silk shades in position.. The gas candle brackets in the lounge were also notable for the beauty of their design. All lighting fittings were turned on and off by distance lighting switches.

FIRE WITHOUT SMOKE.

" Fire without Smoke " was the underlying idea of the exhibit of the South Metropolitan Gas Company at the Building Exhibition (Fig. 2). In this exhibit they showed various types of coke-burning grates and stoves.

The lighted " Metro " coke grate placed in the centre of the exhibit was particularly attractive, and demonstrated the fact that those who still like the solid-fuel fire need no longer use a solid fuel which creates smoke and fogs. The fire was lighted by a special gas burner forming part of the grate. The gas was turned on and off from a convenient point at the side of the fireplace, some two to three feet above floor level.

The frieze of the room in which the coke stoves were exhibited consisted of a silhouette of smokeless chimney-pots against a clear blue sky, and the slogan already referred to stood out well from this background.

Above the fireplace were two of the South Metropolitan Gas Company's latest gaslighting brackets, with very pleasing shell-shaped shades.

Some Results of Better Lighting in the Factory

THIS article is not writen by a lighting expert, but by a production organizer, who, if he does not understand the technique of good lighting, at least appreciates what it stands for in relation to his own work. Consequently, one of his first considerations is the lighting arrangements of the department with which he is at the moment concerned, and even if these are presumably adequate he makes further investigations should the results of his activities fail to come up to expectation.

In most factories the lighting arrangements are presumably adequate, and yet more detailed investigation will show that improvements can be effected which will be beneficial to production. In one factory the stores department consistently failed to keep pace with the demands of the shops, and orders were considerably delayed. Two extra helpers were engaged, which eased the situation to some extent but did not obviate the trouble. The organizer investigated the working conditions of the store, and found out that the lighting arrangements were restricted to two lead lamps, which were the sole means of illumination for six bays.

This arrangement caused no inconvenience during the summer months, as artificial lighting was not necessary, but during the dark afternoons of winter the store assistant had to go from bin to bin collecting details carrying his lighting apparatus about with him. This naturally impeded his movements; but, apart from this, as there were only two lamps it meant that only two assistants could work at one time, and should a third require articles from the bins he either had to wait until one of the lamps was available or borrow from one of the other assistants, this man being idle until such time as his lamp was returned.

Owing to the height of the bays, it was not considered practicable to hang a lamp from the roof, as it would throw a shadow over portions of the bins. Instead, a bracket was fixed in each of the bays and a lamp suspended from this in such a manner that it could be raised or lowered to the position desired. The result was that in a short time it was found possible to dispense with the services of the two additional hands; one of the permanent staff was transferred elsewhere, yet the store was able to meet all demands made upon it.

In another works the lighting circuit was loaded almost to capacity, and the electrician received instructions to relieve the situation by disconnecting a given number of lamps. This was done, but with little regard to the probable effect upon production, and it was not long before complaints of inadequate lighting were received. The production organizer took the matter in hand, charted the affected areas, and requisitioned the services of a lighting specialist. Following this gentleman's recommendations, a rearrangement of the lights was carried into effect, resulting in an adequate service which the circuit could easily maintain.

Some time ago in a certain office there was a surprisingly large number of " short absences," usually from one to two days' duration, amongst the clerks, principally due to headaches, etc. It was suggested that these were caused by eyestrain brought about by the glare of the lights, and eventually the lights were rearranged and deflectors introduced. It was not long before there was a noticeable decrease in the number of " short absences," and the health of the staff seemed much improved.

The nature of the work carried out in a works department usually determines the scope of the lighting arrangements, but sometimes there are two or more different processes carried out in one department which demand variation in the matter of lighting. This is not always appreciated by the management, with the result that the standard service, howbeit quite adequate for the needs of the bulk of the work, is not satisfactory in certain instances. In one factory, for example, a certain department was almost entirely given over to the assembling of parts to comprise a complete unit, but a small section of the department was allotted to the instrument makers, who were concerned with very fine work.

The lighting arrangements were quite adequate for the needs of the assemblers, but were not so successful in the case of the instrument makers. At first the management tried the experiment of placing these men in various parts of the department where the best effects of the lights were felt, but although this resulted in individual improvement it was necessary, to ensure efficiency, for all the instrument makers to work together. Therefore, a portion of the department was screened off for their exclusive use, and the lights in this section arranged according to the need, after which there was no further trouble. These examples serve to show that a little attention to the lighting arrangements will often save money in other directions.

W. J. H.

Lectures on Illumination at the Royal Ophthalmic Hospital (Moorfields)

Two lectures, as part of a series on subjects ancillary to ophthalmology, were given at the Royal Ophthalmic Hospital, Moorfields, on May 1st and 8th by Dr. James Kerr. The first dealt with eyestrain, glare and illumination, and shortly reviewed the physical, ocular and nervous machinery of vision. The improvements needed to facilitate education are exclusion of all small details and fine finger or eye work for children below eight or nine years old, and good lighting for all ages.

The lighting of schools generally should avoid all visible filaments or mantles, and sources should be shaded to have an intrinsic brilliance not exceeding three candles per square inch. Semi-indirect lighting is the type *par excellence* for schools, and cleansing and breakages are such that their avoidance would probably justify wholly enclosed units in translucent shades. The main problem is to evade after-images, even lasting for any considerable fraction of a second, and the glare resulting from bright sources reflected in polished surfaces. Large sources of comparatively low brilliancy are required, and should give an optimum value of about 5 foot-candles on the working place as measured by the lumeter. The simplicity of this measurement was demonstrated.

The second lecture dealt with special educational arrangements to meet the prevalence of chronic strain and the myopia from which 10 per cent. of those leaving primary schools suffer. In four-fifths of these the development of myopia ceases with growth, and if protected till adult life most have no further trouble; but as yet early diagnosis is insufficient to determine safely which are the serious cases likely to cause later inefficiency. The doctrine that school work was the main cause could not be upheld in most of these cases, but its contributory effects could be much diminished by well-distributed and sufficient lighting. Much useful work at present excluded from myope schools would be possible if lessons were short and an illumination of 7 to 10 foot-candles could be secured. At present exact knowledge of the natural history of these cases is wanting, but with the precautions taken in myope classes the rate of myopic change does not appear to be materially greater than normal.

TRADE NOTES & ANNOUNCEMENTS

PHILIPS INDUSTRIAL LIGHTING FITTINGS.

Our attention has been drawn to a new line of industrial lighting fittings, being introduced by Messrs. Philips Lamps Ltd., examples of which are illustrated in Figs. 1 and 2. The advantages of the "NR" fittings are briefly summarized as follows:—(1) uniform distribution of light, coupled with absence of glare, (2) high efficiency and durability, (3) robust construction, (4) improved quality. The reflector is specially

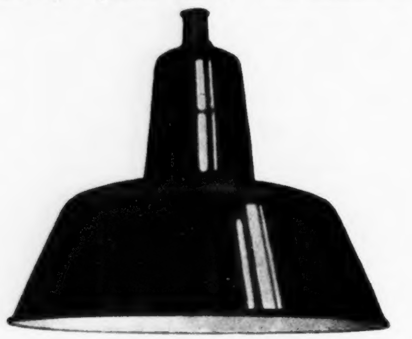

Fig. 1.—Philips "NR" Fitting.

designed to meet requirements arising from the general use of gasfilled lamps, and is intended particularly for industrial use. Attention may be drawn to the depth of the reflector, which in itself helps towards elimination of glare, but it may be pointed out that conditions in this respect are still more satisfactory when "Argenta" lamps (having white glass bulbs) are used. The two forms illustrated are suitable when relatively "extensive" or "concentrating" effects are respec-

Fig. 2.—Philips "AK" Fitting.

tively needed. The latter type (Fig. 2) is specially useful in cases when units have to be mounted at heights of 17 to 33 feet, e.g., for the ligh ing of railway stations and goods yards, crossings and street junctions. Units are adapted for lamps from 300 to 1,000 watts, and each fitting is equipped with a sliding adjustment sc as to facilitate the filament being located in the correct position within the reflector.

NEW ELECTRICAL SHOWROOMS IN MACCLESFIELD.

The new showrooms of the Electricity Company of Macclesfield Ltd. were opened on May 1st by the Mayor of Macclesfield.

The showrooms are designed on somewhat novel lines, the aim being to educate the public to appreciate the varied domestic applications of electricity, and to illustrate the variety of fittings now available. The chief novelty is probably the ingenious expedient of combining the showroom with a café, which, it is hoped, will become a rendezvous for shoppers. It thus serves the double purpose of attracting possible consumers and illustrating the feasibility of a café run on "all-electric" lines. The lighting of the café has some interesting features. At the further end is a stained glass window (floodlighted at night) and the larger part of the ceiling consists of a beaded glass skylight fringed by a series of white enamelled ceiling fittings with "Superlux" globes, each having within it a lamp of a different colour.

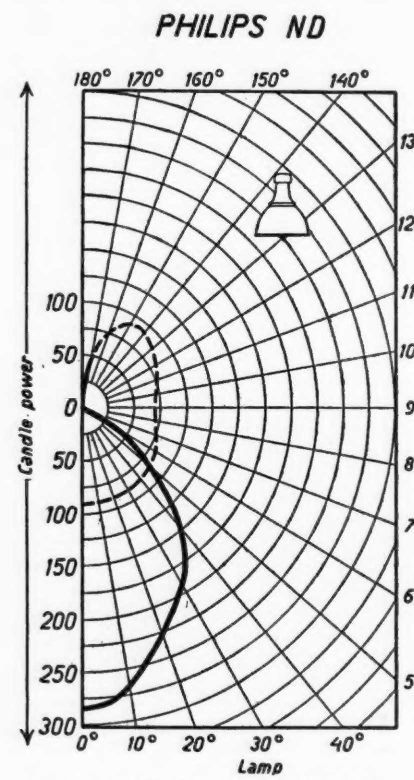

Fig. 3.—Polar Curve of Light Distribution.

BENJAMIN REFLECTOR FITTINGS.

A useful list dealing with "Benjamin" reflector fittings and lighting specialities has been issued by Messrs. Siemens Electric Lamps and Supplies Limited (Catalogue No. 190). Some brief introductory data on the planning of lighting schemes are followed by illustrations of typical installations. Amongst the fittings illustrated special importance attaches to the R.L.M. "One-piece" reflector and to the Biflector fittings with their diffusing rings. Semi-indirect, "Rodalux" and artificial daylight units are also illustrated, and the catalogue as a whole is a serviceable summary of modern reflector fittings.

GREYHOUND RACING TRACKS.

The equipment of greyhound racing tracks has become quite a special field in illuminating engineering. A booklet issued by Messrs. W. J. Furse and Co. Ltd. is devoted mainly to this topic, but also contains some notes on beet sugar factories. The leaflet is attractively got up, and contains a number of effective illustrations of tracks artificially lighted, including that at Wembley, which was carried out in conjunction with Messrs. Metro-Vick Supplies Ltd.

CONTRACTS CLOSED.

The following contracts are announced:—

METRO-VICK SUPPLIES LTD.:

Great Western Railway; for part requirements of Cosmos ordinary and train lighting lamps.

THE K & M "MIRRORLITE" LANTERN.

The K & M "Mirrorlite" lantern, illustrated in Figs. 1 and 2, is a recent introduction of Messrs. Korting & Mathiesen Electrical Ltd., and marks quite a new departure in the design of street-lighting units. The novel feature is the incorporation of a ring of diffusing glass which fringes the reflector. This has a double effect—it helps to screen the filament more completely from view and it enables a small proportion of the light to be emitted upwards, thus eliminating the unsightly shadow line on the faces of the buildings, which is apt to be a feature of installations where opaque reflectors are used. The general effect is illustrated in Fig. 3, which is a photo-

FIG. 1.—General appearance of K & M "Mirrorlite" Lantern (Pattern No. 589, 300 to 1,000 watts).

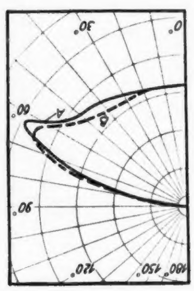

FIG. 2.—Polar Curve :— A—With Ring Filament Lamp. B—With Zigzag Filament Lamp.

graph, taken by the artificial light of a street equipped with "Mirrorlite" units. The downward illumination is exceptionally strong, but the brightness of the surfaces of buildings on either side of the street diminishes gradually as the eye travels upwards.

FIG. 3.—A street illuminated by K & M "Mirrorlite" Lanterns. Note the absence of a hard shadow line on buildings lining the street.

The reflector itself consists of silvered glass, protected by a metal cover. There is free access of air at the bottom, and a space is provided between the metal covering and the mirror to ensure ventilation. The contour of the reflector is specially designed with a view to obtaining an extensive distribution of light, and it is stated that the best results are obtained with a spacing distance of approximately 5 to 5½ times the mounting height. Fuller particulars of this unit are given in the current issue of the *Kandem Quarterly Review*, which contains an interesting survey of modern methods of street lighting.

THE INDUSTRIAL ENGINEER.

In a paper read before the Institute of Fuel Mr. A. J. T. Taylor makes a plea for better appreciation of the services which can be rendered by the industrial engineer. At present he is generally responsible for the care of machinery and for keeping the coal bill down to the lowest consumption. "So long as an engineer's value is measured in terms of his effect on the coal bill, then for so long will he fail to obtain proper appreciation as a professional man."

Met-Vick Fittings in a London Shoe Store.

This picture effectively shows the interior of a department of Messrs. Abbotts Boot & Shoe Store, Oxford Street, London, illuminated by means of Met-Vick fittings with Met-Vick Silverstone Glassware.

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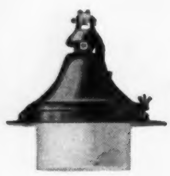

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THE TREPH LAMP FITTING.

It is always interesting to receive particulars of lighting units developed abroad. Leading firms in Germany have been active in this respect, and lighting devices originated in France have illustrated the characteristic trend of this country towards artistic and decorative effects

The Treph fitting, about to be described, emanates from Scandinavia, being the invention of Mr. Poul Henningsen, of Copenhagen. The development of the idea may best be understood by considering what happens when a lamp is mounted within a simple shade, resembling an inverted bell-jar. The light emitted by the lamp directly upwards mainly strikes the higher regions of the reflector, so that its useful effect is only seen from immediately below. The middle section of the light strikes the shoulder of the reflector and is emitted downwards and outwards. A third portion of the light is reflected only by the lower parts of the bell-jar, and their influence is relatively small. There is also a fourth element to be considered—the light which does not undergo reflection at all, but is simply emitted downwards from the lamp filament. It is this portion of the light which is in practice chiefly utilized, with simple reflectors of the type described above. Another circumstance to be considered is that in a bell-shaped reflector there must necessarily be a considerable loss of light from reflection of rays from one part of the reflecting surface to another, leading to progressive loss of light before the light emerges from the shade.

FIG. 1.—A Typical Portable Standard Unit.

The Treph fitting represents an attempt to improve these conditions by dividing the reflector into three zones, space being allowed between individual elements for the light to escape outwards. The wide and almost flat upper shade diffuses light which would ordinarily be largely lost in the upper regions of a reflector; the middle shade represents the shoulder, and the under shade represents the lower portion, which has been brought in towards the centre in order to assist reflection and diffusion from the middle and upper shades.

Naturally careful thought has been given to the design of the contours of these elements, and to the material used for them—a homogeneous sand-scoured glass having excellent diffusing properties. Attention may be drawn to one characteristic feature—that whatever material may be used for the shade (e.g., whether opal or frosted glass) the effect is one of reflection rather than transmission of light. The efficiency of the fittings in general lies between 68 and 71 per cent. The effect is very soft and restful, glare being avoided owing to the complete screening of the filament. Fig. 1 illustrates a typical portable standard, and Fig. 2 a pendent unit.

FIG. 2.—A Pendent Unit.

REVIEWS OF BOOKS AND PUBLICATIONS RECEIVED

National Electrical Safety Code (Handbook of the Bureau of Standards, Washington, No. 3; 4th edition; 1927; *pp.* 525).

The issue of this comprehensive series of safety recommendations, filling over 500 pages, is a good example of the vast amount of useful work done by the Bureau of Standards, which deserves attention from engineers in this country. The code has been carefully revised and contains some new sections, notably the last portion of the work, Part 5, dealing with radio installations. The other four sections deal with rules for the installation and maintenance of supply stations, overhead and underground supply and communication lines, the use of electrical equipment, etc. A point of interest is the attention given to illumination in various sections of the code. Thus, in central stations (paragraph 103) the minimum illumination and "modern practice" illumination is specified in foot-candles for various sections of the building—the only existing regulations, so far as we are aware, definitely requiring certain values of illumination in generating stations. The minimum values range from $\frac{1}{4}$ to 1 foot-candle, the "modern practice" values being either 1–2 or 2–4 foot-candles.

Other regulations deal with the provision of alternative and emergency lighting; for example, in central stations and for exits to assembly rooms, etc., for which circuits fed from a separate source of supply are specified.

Pitman's Technical Dictionary (Sir Isaac Pitman & Sons Ltd., London, 1928, *issued in* 36 *fortnightly parts; 2s. 6d. net per part).*

We have received the first parts of this dictionary, the publication of which has now begun. There will be in all 36 parts, and as nearly 2,000,000 words are rendered in seven languages the publishers are justified in describing this as "a stupendous compilation." Apart from the actual definitions and presentation of equivalents of words and terms in foreign languages, there is much interesting information on procedure in foreign countries, and in Section I there is a suggestive note on the art of technical translation. The difficulties are considerable, and are perhaps not exaggerated by the suggestion that the only way in which to get the correct foreign rendering for a process or object is for this to be shown to the translator without allowing his judgment to be vitiated by the sight of words. In Part I there is a useful section summarizing the main characteristics of the languages dealt with and notes on orthography. The work is something more than a dictionary in that it offers guidance on the choice of alternative expressions, and the sections contain many curious sidelights on conditions abroad—as, for instance, in the treatment of "coal."

It is stated that this is the only work of the kind produced on an English base. Binding cases will be available on the completion of each volume.

INDEX (June, 1928).

The Illuminating Engineer

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SPECIAL INFORMATION.

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SINCE the year 1909, when the Illuminating Engineering Society was founded in London, it has been the official organ of the Society.

IT is *the only journal in this country exclusively devoted to Lighting by all Illuminants.*

IT receives the assistance of contributors who are leading experts on illumination in this country and abroad. Foreign Notes and News will be a speciality, and correspondents have been appointed in all the chief cities of the world.

THE Journal contains *first-hand and authoritative information on all aspects of lighting;* it has also been improved and extended by the inclusion of a *Popular and Trade Section* containing special articles of interest to contractors, gas and electric supply companies, Government Departments and members of the Public.

DISCUSSIONS before the Illuminating Engineering Society which are reproduced in this Journal are participated in alike by experts on illumination and *users of light*, whose co-operation is specially invited.

Good Lighting is of interest to everyone. The Journal is read by engineers, architects, medical men, factory inspectors, managers of factories, educational authorities, public lighting authorities, and large users of light of all kinds.

BESIDES being issued to all members of the Illuminating Engineering Society, the Journal has an independent circulation amongst people interested in lighting in all parts of the world. The new and extended form of the Journal should result in a continual and rapid increase in circulation.

Every reader of THE ILLUMINATING ENGINEER, the Journal of GOOD LIGHTING, *is interested in illumination, and is a possible purchaser of lamps and lighting appliances. Gas and Electricity Supply Undertakings likewise benefit by the movement for Better Lighting, with which the Journal is associated, and which stimulates the demand for all illuminants.*

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